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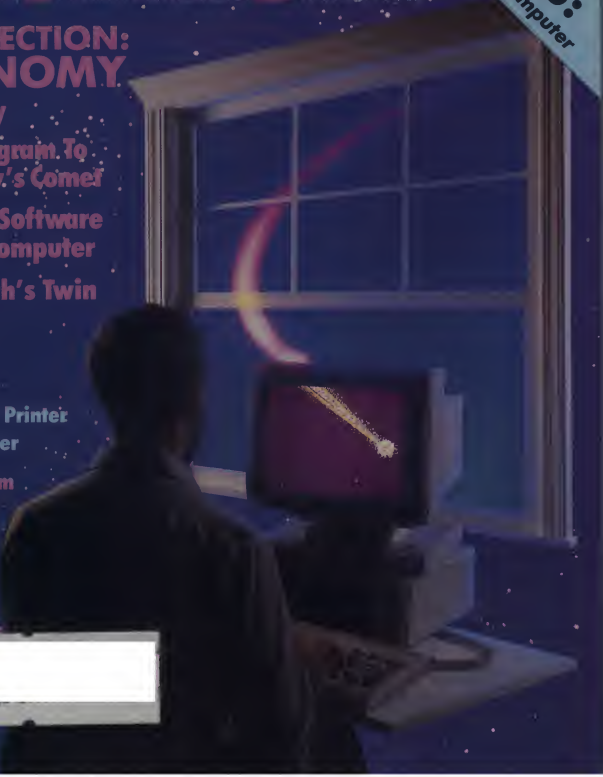

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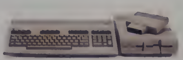

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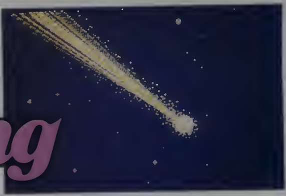
VOLUME 11 NUMBER 11 NOVEMBER 1985

Creative Computing



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CIRCLE 121 ON READER SERVICE CARD

INPUT/OUTPUT

More Efficient 3-D Fractals

Dear Editor:

I was fascinated by your article on 3-D Fractals (1985 July). I found a couple minor errors in the Apple II listing and two interesting variations.

In line 510 there is an *oh* where there should be a *zero* (in the expression Z2 < 0). In line 110 the keyword REM is omitted at the beginning of that remark statement.

I found the selection of land color to be odd in line 1090 so I changed it. Instead of using HCOLOR = 7 for white I used either 5 for brown or 1 for green. Admittedly the brown is really orange, but it does look more like land than does the white. The green alternative is also pleasant making the landscape appear to be covered with vegetation.

Finally I worked out a way to add snow to the tops of the mountains. (Using white for the snow requires using brown or green for the land and brown seems more reasonable with the snow.) I moved line 470 down to 472 and added new lines 470 and 471 as follows:

```
470 IF ZZ>SL OR Z2>SL THEN
    HCOLOR=7
471 IF (ZZ>0 AND ZZ<=SL) OR
    (Z2>0 AND Z2<=SL) THEN
    HCOLOR=5
472 IF XO<-999 THEN 500
```

In addition, the value of SL (the snow level) must be initialized; I did it in line 55:

```
55 SL=750
```

Various values from 500 to 1000 seem to give good results.

I hope your readers find this an interesting variation.

William Hooper
Clinch Valley College
Wise, VA 24293

Dear Editor:

I very much enjoyed your article on 3-D Fractals by Michiel van de Panne. The program worked very well, and it generates very nice graphics. Also, fractals are a relatively new field of mathematics and the article may interest some non-mathematicians in fractals.

Although the program runs fine, some minor changes can cut the running time in half. The rotation formulas used in the program are very inefficient. The following new formulas will speed up the program:

Replace lines 770 to 840 with the following:

```
770 OX = XX
780 XX = XX * RC - YY * RS
790 YY = OX * RS + YY * RC
800 RETURN
```

Replace lines 860 to 920 with the following:

```
860 OX = XX
870 XX = VC * XX - VS * ZZ
880 ZZ = VS * OX + VC * ZZ
890 RETURN
```

Also, add the following lines:

```
51 RC = COS (RH):RS = SIN (RH)
52 VC = COS (VT):VS = SIN (VT)
```

Change line 50 to:

```
50 MX = DS - 1:MY = MX / 2:PI
   = 3.1416:RH = PI / 6:VT =
   - PI / 5
```

There are also some minor, unnecessary changes which will just streamline the program. All these changes are for the Apple version, but should apply to other computers, too. You can change the following lines:

```
40 DS = 2 ^ LE + 1

180 D = (D1 + D2) / 2 + (RND
    (1) - .5) * L / 2:AX =
    XE:AY = YE:GOSUB 420

250 D = (D1 + D2) / 2 + (RND
    (1) - .5) * L / 2:AX =
    XE:AY = YE:GOSUB 420

330 AX = XE + YE:AY = YE:D =
    (D1 + D2) / 2 + (RND (1)
    - .5) * L / 2:GOSUB 420

1040 IF XO = - 999 THEN X8 =
     XP:Y8 = YP:XO = X
```

If you made the change to line 1040 then delete 980 and 985.

All those changes should result in an easier to read and much faster program. I hope that you will include in your magazine many more articles on similar mathematical subjects. Thank you for an entertaining and interesting magazine.

Danny Cory
(Age 14)
55 Cedar St.
Chapel Hill, NC 27514

20-Bit Addressing

Dear Editor:

The June 1985 issue of *Creative Computing* contained an excellent article by Douglas Kerr titled "It's 16 Bits, But Is That Wide or What?" concerning the differences between 8-bit and 16-bit microcomputers. A sidebar to that article explained how the IBM PC comes up with 20-bit addresses. I wonder if Mr. Kerr could provide an example of the 20-bit addressing scheme using actual addresses.

Keith Carver
4616 A Pkwy.
Sacramento, CA 95823

Suppose the CPU wishes to develop the memory address for the fetch of the next instruction. It takes the value in the appropriate segment register (in this case, CS, the "code segment" register, which is normally used with instruction addresses) and multiplies it by 16 by shifting it left four bits. This gives the "segment base," the address of the beginning of the current code segment—a 20-bit number. Then the offset of the desired address (how far it is above the segment base), held in the IP (instruction pointer) register, is added. The result is the full 20-bit address of the next instruction.

Below is an example, shown in hexadecimal. Remember that each hexadecimal digit represents four bits and that a shift left by four bits appears as a one-place shift in the hexadecimal form.

The address in the example is sometimes represented, in certain types of listings or in DEBUG display, like this: 1800:11A3. —*DAK*

Value in CS	1800	(16 bits)
Shift left 4 bits	18000	segment base address (20 bits)
Add value in IP	11A3	instruction offset (16 bits)
Sum	191A3	instruction address (20 bits)

Correction

On pages 50 and 64 of the September issue, the price of the Zenith ZVM-133 monitor is listed as $309. The correct price is $559.

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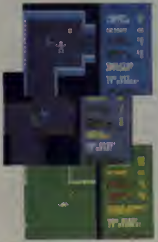

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CIRCLE 108 ON READER SERVICE CARD

INDUSTRY INSIDER

David H. Ahl

Microsoft, IBM Sign Pact

In late August Microsoft and IBM signed a long-term agreement for joint development of operating systems and other software. William Gates, chairman of Microsoft, said the companies were pursuing software projects in networking, communications, and a user interface as well as continuing development of PC DOS (MS DOS). All products developed under the agreement would be licensed to both IBM and Microsoft. Microsoft would be free to remarket and license the products to its other customers as well.

The agreement is "long term" without a specific ending date. No payments were made to Microsoft; rather, payment for each project will be negotiated separately. Under the agreement, long-term plans can be discussed more openly which should prevent the development of similar but incompatible products like IBM's Topview and Microsoft's Windows.

Third party software publishers as well as makers of IBM compatible computers were pleased with the agreement, because it appears to commit IBM to the "open architecture" concept. Makers of clones have been fearful that IBM would market a new, proprietary operating system that would cut them out of a lucrative market.

The agreement is a welcome one to Microsoft which now gets about 10% of its annual $140 million in revenue from IBM. Slightly less than half of the firm's revenues come from the sales of systems software and the balance from applications software. Microsoft had expected considerably more payoff from its commitment to the Apple Macintosh. Gates said, "We once thought Macintosh would account for half of our retail application software sales, but that was based on the assumption that (Apple) would do a good job."

Can Amiga Save Commodore?

Reeling from a $50 million inventory writedown in the fiscal quarter ended June 30, 1985 and a 50% decline in sales in the first half of 1985, top officials from Commodore hit the road in August to drum up support for the Amiga.

Commodore officials are visiting 40 or so cities to sign up dealers for the Amiga. As of late August only 260 dealers had signed up. No deals had been reached with any major retail chains, although the Computer Factory, a 20-store New York-based chain, has signed up. A Commodore spokesman said that deals with several major chains are "imminent."

Despite rave reviews in several magazines, Commodore already seems to be on the defensive about the technically dazzling Amiga. Commodore spokesman Joe Thorsen cites its ability to run IBM PC programs with the addition of $100 conversion program but apologizes that it will run "a tad bit slowly." (See Commodore's Port.) He fails to mention that it also requires an external 5.25" disk drive. Why the emphasis on IBM PC software so soon? The Amiga is hardly a PC clone and we can't imagine that PC compatibility should be a prime selling point.

Will the Amiga save Commodore? Not with marketing like this.

Japan Lifts Tariffs

Japan recently agreed to lift all tariffs on computers, peripherals, and parts effective April 1, 1986. The U.S. agreed to lift tariffs on parts (circuit boards and subassemblies) only. Originally the Japanese wanted a mutual lifting of all tariffs by both nations, but Deputy U.S. Trade Representative Michael Smith said this was not acceptable. Smith said, "We insisted that Japan remove all tariffs on CPUs and peripherals as well (as parts) to come up with a balanced computer trade agreement."

Semiconductors and integrated circuits are not included in the agreement as both countries have previously eliminated tariffs on these devices.

Although the resulting balance of trade should work in favor of the U.S., some analysts think that the Japanese will still favor products made in Japan. Nevertheless, in the first half of 1985 U.S. computer exports to Japan totaled $686 million, a 45% increase over the year earlier period. Despite this increase, the U.S. still had a $797 million trade deficit in computers with Japan in the first six months of 1985 and nearly a $2 billion deficit for all of 1984.

Random Bits

AT&T has announced it will eliminate 24,000 jobs from its Information Systems Division, the largest single layoff in U.S. business history. The firm blamed the massive overlap in positions as a result of merging AT&T Technologies (formerly Western Electric) with AT&T Information Systems last July, but outside analysts also point to the softening of the computer market . . . **Commodore International** also said it would lay off 700 employees or about 15% of its work force. The company recently wrote down $50 million of slow-selling inventory and expects to post a $70 million loss for the year ended June 30, 1985.

The Federal Communications Commission (FCC) staged a raid July 24 on **Seequa Computer Corp.** for selling computers that violate FCC radio wave emission levels. Seequa had received a previous citation and fine but failed to bring their machines into compliance. FCC spokesman Paul Harris said, "They were grossly in violation of our rules." The FCC referred over 20 criminal charges against Seequa executives to the U.S. Attorney's Office in Baltimore.

Steve Jobs, chairman of Apple but now eased out of active management, has sold 1,350,000 shares of his Apple stock for about $22 million. Rumors are that he plans to start a new venture. After the sale Jobs is still the company's largest shareholder with about 5.5 million shares, or 9.1% of the company . . . After soaring in sales following its introduction in June, Lotus **Jazz** (for the Macintosh) has fizzled out. Dealers blame its slowness and clumsiness (see review in October *Creative*). Some also feel that it sells poorly in large corporations—the main users of integrated software—because the Mac itself is not widely accepted by such customers. ■

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```
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```

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```
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PULLED OFF. AROUND HER NECK
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OF CARRYING AROUND
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```
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```

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```
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TRY THIS!

The world finder: Searching for the Earth's twin

Edward H. Carlson

Look up into the clear night sky. If you are away from city lights you see about 2500 stars with your naked eye. (Seems like a lot more, doesn't it?) Astronomers believe many of these stars have planetary systems. Which ones? Could you be looking toward worlds that are similar to Earth in size, temperature, atmosphere, and living conditions? Let's explore our Milky Way galaxy, using the computer as a spaceship on a journey to find the Earth's Twin. In this quest, we will come across many strange worlds inhabited by fantastic lifeforms.

We must first make the standard science fiction assumption—that we have a deep space hyperdrive to tunnel through space-time and thus greatly exceed the speed of light. We don't want our journey to take millions of years. But this is our only concession to the fiction folk. We will otherwise stick to what the astrophysicists believe about planets and their habitability—that is, when these wizards can agree in this rapidly developing field of study.

One short article cannot teach a whole book full of astronomy, so refer to your encyclopedia when you run across unfamiliar terms. On the other hand, the program in Listing 1 will crunch the numbers and spit out the particulars on any planet we run across—its size, surface gravity and temperature, length of day and year, satellites, composition, life chemistry, and geological age.

To find out what kinds of planets we might find roving about what kind of stars, we peek under the cabbage leaf and watch the birth of stars and planets.

Planets form at the same time their central star is born—from the same cloud of gas and dust swirling chaotically in a spiral arm of the galaxy. The gigantic, cold, tenuous cloud is mostly hydrogen gas mixed with 20% helium gas and containing about 2% dust—specks containing water ice, other ices (ammonia, methane) with smaller amounts of "sand" (silicate grit) and iron.

As the cloud contracts under its own gravitational attraction, its swirling must speed up, obeying the same principle by which an ice skater, starting in a slow spin, speeds up by pulling her arms in to her body. What happens next is the subject of immense computational effort on the world's fastest computers. Most often the cloud breaks up into pieces, each contracting to form a star, so binary, triple, or multiple star systems result. Such systems may be too unstable to allow planets to form. But in about 10% of the cases, a single star with planets is born from a cloud fragment spinning so fast that it flattens into a disk, the planetary accretion disk, whose central bulge becomes the star.

The contraction process heats the disk, and the central regions become so hot that the ices evaporate. Near the central bulge, the silicate and iron also vaporize. In the central bulge itself (if hot and massive enough) thermonuclear reactions create the life spark of the newborn star which cannot cool off again until its hydrogen fuel is used up. But the disk itself does cool by radiating its heat away, recondensing its gases back into iron particles, silicate grains, and far enough away from the star, ices. These particles collide and stick together, forming planetesimals which attract each other gravitationally, forming the planets and satellites. Gas, dust, and vapors that are not captured by the growing planets eventually escape into interstellar space.

The whole process takes somewhere in the range of a million to tens of millions of years—a short time compared to the 4.55 billion year age of the solar system and the approximately 13 billion year age of our galaxy.

From the largest clouds come massive stars and perhaps massive planets. I say "perhaps" because massive stars are so bright and hot that they may evaporate the cloud before the planets can properly form. Then again, they may not. We have good data for only one case, our own solar system, and the sun is not particularly massive (though it is more massive than the average star).

You might think a massive star would take a long time to burn its hydrogen into helium, but this is not so. A star 30 times more massive than the sun burns 150,000 times more brightly, running through its fuel in only a few million years versus the 10 billion year life span the sun can expect. We may satisfy our curiosity by looking for planets near the really bright stars we see in the sky, such as Spica, Rigel, and Vega, but we won't want to settle down on one of their planets—raw and uncivilized by life—because the star may "soon"' swell up into a red giant, engulfing the innermost planets, and then later explode as a supernova.

The composition of a growing planet depends on how hot its part of the gas-dust cloud is, which in turn depends on the distance of the planet from the central star. The central parts of the accretion disk are too hot to allow ices to condense, so the planets formed there are rocky—composed of a dense iron core surrounded by silicate rocks. In our solar system, Mercury, Venus, Earth (and its Moon), Mars, and probably the asteroids are rocky.

Planets formed farther out are more massive but less dense, composed mostly of ices. If they are massive enough to attract and hold hydrogen and helium gases, they become giant gas balls. (If the gas ball is large enough, its central regions heat to the ignition point of fusion nuclear reactions, and the "planet" becomes a small star.) Jupiter, Saturn, Uranus, and Neptune are gas ball planets. Pluto is probably an icy planet—most likely an escaped moon of Neptune.

Thus a sharp boundary occurs at the "condensation-of-ice radius" of a planetary system. Inside this radius are the rocky "terrestrial" planets, outside are the icy and gas ball planets. The condensation-of-ice radius is about 4 AU in our solar system—between the asteroid belt and Jupiter. (AU stands for Astronomical Unit, the 93 million mile yardstick used to measure distances in planetary systems. It is the distance of the sun from the earth.)

Using the Program

In the program in Listing 1, you first pick the mass of the star you wish to investigate. The brightness of the star and its lifetime depend only on its mass. A cube five light years on a side in our part of the Milky Way galaxy would probably contain one star of mass and brightness similar to the sun and several that are fainter. To find a star that is a hundred times brighter than the sun, we should look in a cube that is at least 30 light years on a side. (The center of our Milky Way galaxy lies about 30,000 light years away. You are looking toward it when, in the summer sky, you look near the "pouring spout" of the "teakettle"

Listing 1.

```
1 GOTO 1000:--------------------- EARTH'S TWIN ----------------------------
2 REM file name:EARTH                disk name:CC                  E. H. Carlson
100 REM ------------------------- stellar type ----------------------------
306 CLS:PRINT                            :REM clear screen
308 PRINT "                     STELLAR TYPES":PRINT
310 PRINT "     Type         Temperature     Life time          Mass ":PRINT
311 PRINT " Blue giants     UV hot          Very short      30   to  3 "
312 PRINT " Transition      Blue hot        Short            3   to  2"
313 PRINT " Solar types     White hot       Long             2   to   .5"
314 PRINT " Red dwarfs      Red hot         Very long       .5   to   .1"
315 PRINT:PRINT" Mass units = sun's mass":PRINT
320 INPUT" Star mass";M:IF M>30 OR M<.1 THEN 320
321 RANDOMIZE M
322 L     =EXP( 3.5*LOG(M)):PRINT      :REM find star brightness
323 TA    =EXP(-2.5*LOG(M))*10000!     :REM find star lifetime
324 Q=10:X=L   :GOSUB 900: L  =X       :REM round off before printing
325 Q=10:X=TA  :GOSUB 900: TA =X       :REM round off before printing
328 FOR J=1 TO 63:IF M>S(J) THEN 330   :REM find star spectral type
329 NEXT J
330 PRINT "spectral type of star:  ";S$(J)                              :PRINT
332 PRINT "luminosity of star:     ";L ;"times the sun's brightness":PRINT
334 PRINT "lifetime of star:       ";TA;"million years"                :PRINT
336 IF TA>12000! THEN PRINT "The star may be as old as the galaxy"  :PRINT
338 PRINT "If there is a planetary system:"                             :PRINT
340 IF TA< 100 THEN PRINT T$(0):GOTO 350:REM star may explode
342 IF TA< 700 THEN PRINT T$(1):GOTO 350:REM no life forms
344 IF TA<2000 THEN PRINT T$(2):GOTO 350:REM no oxygen in atmosphere
346 IF TA<4100 THEN PRINT T$(3):GOTO 350:REM may be lower  life forms
348 :                PRINT T$(4)         :REM may be higher life forms
350 PRINT:PRINT"Do you want to investigate this star?"
352 Y$=INKEY$:IF Y$=""              THEN X=RND(9):GOTO  352
354 :          IF Y$="y" OR Y$="Y" THEN           GOSUB 400
399 PRINT:END
400 REM ---------------------- planets in system ----------------------------
403 CLS:PRINT:PRINT                            :REM clear screen
404 SA=RND(9)*TA:IF SA>13000 THEN SA=13000 :REM age of planetary system
405 Q=10:X=SA   :GOSUB 900:SA   =X          :REM round off before printing
406 PRINT:PRINT"We find the system is";SA;"million years old."
407 PRINT:PRINT"(Solar system age = 4550 million years.)"
408 IF SA=13000 THEN PRINT:PRINT"Population II star, low in heavy elements."
409 PRINT
410 REM ---------------------------- orbits ---------------------------------
411 NP   =6+INT(RND(9)*5)                  :REM number of planets
412 SC   =.3*SQR(M)*(.9+RND(9)*.2)*8/NP:REM scale of planetary disk
414 A    =SC                               :REM radius of 1st orbit
420 FOR I=1 TO NP                          :REM modified Bode's law
423 A    =A*1.7*(.8+RND(9)*.4)             :REM radius of ith orbit
425 T(I) =SQR(A^3/M)                       :REM period of planet about star
427 E(I) =.01*RND(9)*9                     :REM eccentricity of orbit
430 REM ----------------------------- mass ----------------------------------
432 AC=4*L*L                               :REM condensation-of-ice radius
434 A2=A^2                                 :REM orbit radius squared
435 MC=M* 1*(.3+RND(9)*1.4)*A2             :REM rocky core scales with disk area
436 MC=MC*.3^(A/4):MP=MC                   :REM accretion disk thins toward edge
437 IF A>AC   THEN MP=MC*12                :REM ices condense on rocky dust
438 IF MP>  3 THEN MP=MP^1.5               :REM beyond grav. growth threshold
439 IF MP>999 THEN MP=MP/2:GOTO 439
440 IF MP<.01 THEN MP=.01
442 REM ------------------------- composition -----------------------------
444 :             C$(I)="rocky"
446 IF A>AC THEN C$(I)="icey"
448 IF MP>3 THEN C$(I)="gaseous"
450 REM ------------------------ planet radius ----------------------------
451 R=MC^.33                               :REM radius of rocky core
452 IF MP<>MC THEN R=(MP*5)^.33            :REM gas ball planet has large radius
454 REM ----------------------- surface gravity ---------------------------
456 SG=MP/R/R                              :REM surface gravity compared to earth
458 MP(I)=MP:A(I)=A:R(I)=R:SG(I)=SG       :REM store values
460 REM -------------------------- satellites -----------------------------
462 IF MP<2   THEN NM(I)=INT(RND(9)+.6):GOTO 490
464 IF MP>2   THEN NM(I)=INT((5.6*RND(9))+RND(9)*5*LOG(MP))
490 NEXT I
500 REM ----------------- planets' physical conditions --------------------
520 FOR I=1 TO NP                          :REM orbital geometry
524 TI(I)=.1*RND(9)*3                      :REM tilt of planet rotation axis
526 D(I) =1                                :REM day length (fix up)
528 ST(I)=290*SQR(SQR(L)/A(I))             :REM surface temperature of planet
530 IF ST(I)> 173 AND C$(I)="icey" THEN MP(I)=MP(I)/12:C$(I)="rocky"
532 IF ST(I)>2000                   THEN MP(I)=0        :C$(I)="evaporated"
538 NEXT I:       GOSUB 700                :REM print table
```

in Sagittarius.)

The program then semirandomly generates a typical planetary system for the star you picked. The program uses our understanding of the physical processes that give rise to planets, which are best understood for our own planetary system. So the planets generated for stars of mass M=1 (that is, a mass equal to one solar mass) are most plausible. The systems generated for stars of much different mass are, frankly, speculative.

The radii of the orbits come from a modified Titius-Bode Law—the radii increase roughly in a geometrical series as you move out from the sun or star. I also assumed that the mass of the planetary accretion disk was proportional to the mass of the star. Then using the inverse square law of light intensity vs. distance from a source (star) to determine the condensation-of-ice radius, and Kepler's Laws of planetary orbits, the planetary system can be constructed. By the way, when I say "the surface radius" of a gas planet like Jupiter I mean the radius of the gas ball, not the radius of the small solid core that may lie deep within the planet.

As you run the program, it quickly becomes obvious that few planets match the Earth in temperature, gravity, and composition. If the orbit of Earth were somewhat larger or smaller in radius, the oceans would freeze or boil. If the gravity were weaker, our atmosphere would escape. If stronger, the atmosphere would differ in composition from the familiar 80% nitrogen and 20% oxygen we breathe.

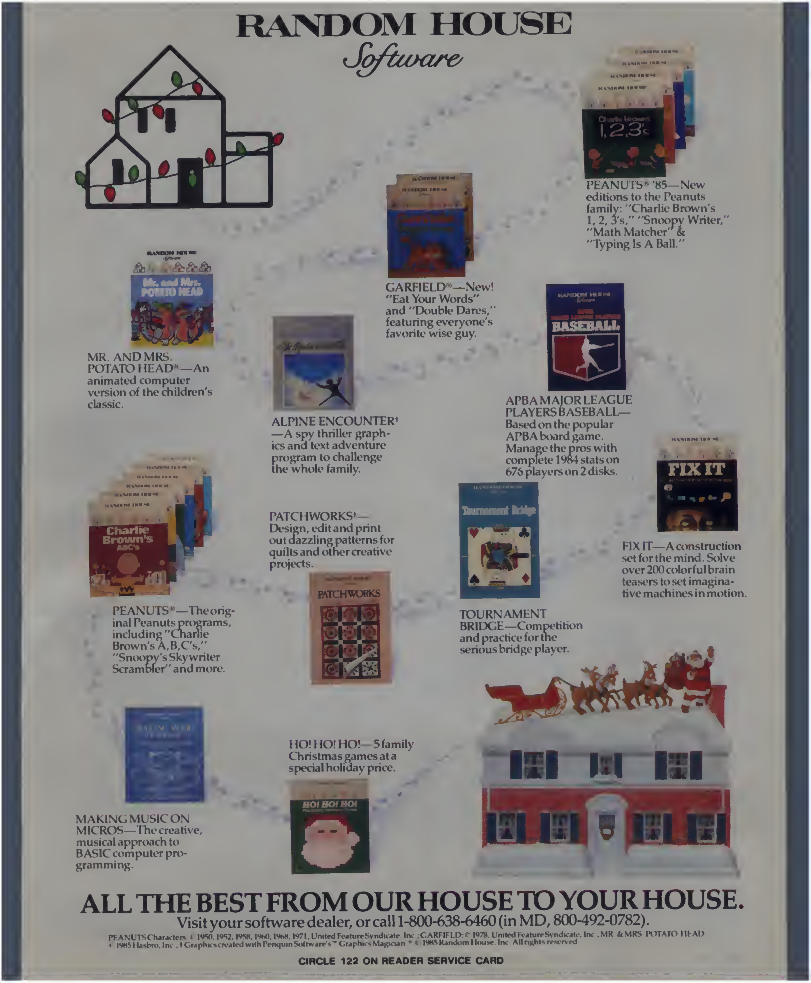
An iceball world, even one having Earth gravity, may be very difficult to live on. Earth astronauts will test this out first hand in the next century, visiting the satellites of Jupiter, Saturn, Uranus, and Neptune.

Listing 1. *(continued)*

```
550 REM atmosphere (greenhouse?), tectonics
560 REM now seasons from the above
599 RETURN
600 REM ----------------- planet's surface conditions -------------------------
610 REM surface chemistry, geography, oceans?, climate, life forms
699 RETURN
700 REM -------------------- print planetary table ----------------------------
712 PRINT:PRINT:PRINT"                                     PLANETS "     :PRINT
716 PRINT "      orbit     period     mass  surface  surf.  composition moons"
718 PRINT " #    radius                     gravity  temp.   ":PRINT
730 FOR I=1 TO NP
732 Q=10:X=A(I) :GOSUB 900:A(I) =X      :REM round off before printing
734 Q=10:X=SG(I):GOSUB 900:SG(I)=X
736 Q=10:X=MP(I):GOSUB 900:MP(I)=X
738 Q=10:X=ST(I):GOSUB 900:ST(I)=X-270
740 Q=10:X=T(I) :GOSUB 900:T(I) =X
742 PRINT I;TAB(5):IF C$(I)="evaporated" THEN PRINT C$(I):GOTO 770
744 PRINT USING "###.##";A(I);          :REM print orbit radius
746 PRINT TAB(14);
748 PRINT               T(I);           :REM print period (year)
750 PRINT TAB(23);
752 PRINT USING "###.##";MP(I);         :REM print mass of planet
754 PRINT TAB(30);
756 PRINT USING "###.##";SG(I);         :REM print surface gravity
758 PRINT TAB(40);
760 PRINT USING "####." ;ST(I);         :REM print surface temperature
762 PRINT TAB(50);
764 PRINT               C$(I);          :REM print surface composition
766 PRINT TAB(60);
76B PRINT NM(I)                         :REM print number of moons
770 NEXT I
772 PRINT:PRINT "units: AU      years    earth's earth's   C    "
799 RETURN
900 REM --------------------- round off function ----------------------------
906 IF X=0 THEN                                              RETURN
910 N=0:          IF X<  2*Q THEN                       930
914 :             IF X>=20*Q THEN X=X/10:N=N+1:GOTO 914
918 X=INT(X+.5) :IF N=    0 THEN                             RETURN
920 FOR K=1 TO N:X=X*10:NEXT K:                              RETURN
930 :             IF X<  2*Q THEN X=X*10:N=N+1:GOTO 930
934 X=INT(X+.5) :IF N=    0 THEN                             RETURN
936 FOR K=1 TO N:X=X/10:NEXT K:                              RETURN
1000 REM ===================== DESCRIPTION ==============================
1005 CLS:PRINT:PRINT:PRINT                 :REM clear screen
1020 PRINT"                               The Earth's Twin":PRINT
1030 PRINT"    Come search the galaxy for a twin planet to Earth--one we can"
1031 PRINT"    colonize.  We pick a nearby star that has a desirable mass."
1099 PRINT
1100 LOCATE 22,2:PRINT"Press the SPACE BAR to continue"
1110 Y$=INKEY$:IF Y$<>" " THEN X=RND(9):GOTO 1110
1999 PRINT" Wait"
2000 REM ===================== INITIALIZATION ===========================
2120 DIM ST(20), S(65),S$(65)
2160 DATA 30,26,23,19.9,17.3,15.1,13.2,11.5,10,8.4,7.1,6,5,4.2,3.6,3,2.9,2.7,
2.6,2.5,2.3
2161 DATA 2.2,2.1,2,1.91,1.82,1.73,1.65,1.57,1.49,1.42,1.35,1.28,1.22,1.16,
1.11,1.05,1,.95,.9,.85,.81,.77,.73,.69,.66,.62,.59,.56,.53,.51,.4B,.46,.43,.41
2162 DATA .39,.37,.35,.33,.25,.1B3,.135,.1
2165 DATA O5,O6,O7,O8,O9,B0,B1,B2,B3,B4,B5,B6,B7,B8,B9,A0,A1,A2,A3,A4,A5,A6,A7,
AB,A9,F0,F1,F2,F3,F4,F5,F6,F7,F8,F9,G0,G1,G2,G3,G4,G5,G6,G7,GB,G9
2166 DATA K0,K1,K2,K3,K4,K5,K6,K7,KB,K9,M0,M1,M2,M3,M4,M5,M6,M7
216B :             FOR J=1 TO 63:READ S(J)  :NEXT J
2169 :             FOR J=1 TO 63:READ S$(J) :NEXT J
2180 T$(0)="   The star may explode in the near future!"
2181 T$(1)="   The system is too young for life to have developed."
2182 T$(2)="   There may be unicellular life, but no oxygen on any planets."
2183 T$(3)="   There may be oxygen and lower lifeforms present."
21B4 T$(4)="   There may be higher lifeforms on some planets."
2999 GOTO 100                               :REM go start main sequence
8000 REM Written in BASICA on an IBM PC with an 80 col. green screen monitor.
8002 REM For some other computers, use GET for INKEY$; and HTAB, VTAB for
8004 REM LOCATE.  These are not exact replacements, see your manuals.
9999 REM +----+----+----+----+----+----:----+----+----+----+----+----+----
```

Expanding the Program

The program as it stands is fun and instructive, but leaves many topics you may want to develop further. After visiting your local library for astronomy books, you can tune up the calculations in many places, for example the length of planet days and the density of the planets. Finish the satellite construction that I began. The satellites come from two sources: The gas ball planets have some satellites—the Galilean moons of Jupiter, for example—that apparently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formed in a miniature accretion disk, just like the solar system as a whole. Other satellites are apparently captured asteroids or large planetesimals. So you may want to give your planetary systems some asteroids, formed in a belt inside the orbit of the largest planet. The gravitation of the giant planet disrupts the process of planetesimal accretion for the next inner planet. Comets—kilometer sized ice balls formed far out in the planetary accretion disk—add a decorative touch.

If you like chemistry, play around with the composition of the planets, moving on to geology, then to weather and climate. Finally, explore the implications all this has for biology. Invent lifeforms to fit the various living conditions on the planets. Drop me a letter (c/o *Creative Computing*) or leave a message on the Creative Computing CompuServe SIG (type GO PCS 22 at any function prompt) about your extensions. If I perceive enough interest, I will reopen the subject in a later column. I am especially eager to become acquainted with the creatures, gentle and ferocious alike, of the other worlds.

Become acquainted with the creatures, gentle and ferocious alike, of other worlds.

But the first task is to locate our home away from home. I suggest you modify the program to search automatically many suitable stars for earthlike planets, keeping track of the number of systems investigated. Start it running at bedtime and see if morning brings a rosy dawn on the Earth's Twin. ■

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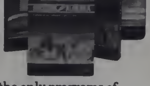

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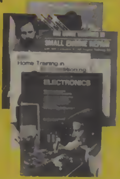

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BOOK REVIEWS

Logo, education, and help for parents/**Russ Lockwood**

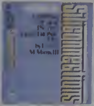
The Silicon Jungle by David H. Rothman. Ballantine Books. Paperback, 385 pages, $3.95

The premise of The *Silicon Jungle* is to provide advice to would-be microcomputer buyers. Rothman does a fine job treading that well-worn path, and if that were the only aspect of the book, we'd say "nice try, but nothing special."

However, packed around practical information is a cornucopia of microcomputer history, folklore, and reminiscences worthy of Trivial Pursuit. With vigor and freshness, Rothman punctuates each aspect of buying a computer system with several anecdotes—all designed to prove a particular point. Some examples include finding GOD on MCI Mail, Raquel Welsh and ergonomics, and Arthur C. Clarke and telecommunications.

If you already own a computer system, the *Silicon Jungle* is probably not for you. However, if you are in the market for a system, take a look at Rothman's book. At $3.95, it will set you back only a fraction of the cost of a specialty book.

Siliconnections: Coming of Age in the Electronic Era by Forrest M. Mims III. McGraw-Hill. Hardcover, 240 pages, $16.95



Forrest M. Mims III, no stranger to readers of *Computers & Electronics* and *Creative Computing*, takes us on a whirlwind tour of the microcomputer revolution. Based on personal recollections, Mims describes the birth of the microcomputer, the rapid growth of the silicon world, and the boom-bust cycle of computer magazines. He provides behind-the-scenes details about an Air Force laser laboratory, his efforts to eavesdrop on Howard Hughes' conversations for the *National Enquirer*, and the court battle with Bell Labs over rights to his invention, the fiberoptic telephone.

Siliconnections bursts upon your siliconsciousness with a vivid description of a high tech practical joke at the University of New Mexico. Mims and several students concocted a story about UFOs and deathrays. Mims, perched atop a roof and armed with a deadly-looking but otherwise harmless helium-neon gas laser, carefully zapped several co-conspirators, causing pandemonium below until the "outgunned" campus police called in the real cops.

Mims continues with the story of his involvement in the MITS Altair 8800, the first real microcomputer, with Ed Roberts and others. His personal model, along with previous electronic projects and documentation, now resides in the Smithsonian.

The entire book is a joy to read. Best of all, it is a first person account by a bona fide pioneer. Those who want the inside story about the microcomputer revolution should pick up *Siliconnections*.

Apple II/IIe Robotic Arm Projects by John Blankenship. Prentice-Hall. Hardcover, 149 pages, $21.95

In the "In Real Time" column of the April 1985 issue, we examined some uses of personal computers at the Kearfott division of Singer Co. One of these was an Apple-powered robotic arm used to research the use of robotics on industrial assembly lines. This book, for those with drive and skill, discusses how to construct a small-scale, Apple-controlled robot arm.

John Blankenship, senior professor at DeVry Institute of Technology, has taken much of this "project" from his teaching experience. He examines the theories and practices of construction, provides Basic programs to control the arm, and lists sources for parts. For those who lack the time and money to build their own arm, Blankenship includes several programs that create a video simulation of robotic arm manipulation.

Blankenship serves up a practical guide to constructing and experimenting with robotic arms. Be forewarned, however, this book is only for the true robotics aficionado.

Handbook for Space Colonists by G. Harry Stine. Holt, Rinehart and Winston. Softcover, 273 pages, $11.95

Since the theme for this issue is space, what better book to get than *Handbook for Space Colonists*, an interesting introduction to traveling, working, and living on the final frontier.

Stine, a consultant to NASA and science fiction author (under the pen name Lee Correy), examines the physiological and psychological effects of being in space and points out potential hazards and risks. He explains our tolerance of temperature, humidity, acceleration, gravity, and radiation and discusses weightlessness, medical care, sanitation, and personal hygiene.

Profusely illustrated with NASA photos and drawings from Rick Sternbach (of the television series "Cosmos" fame), *Handbook for Space Colonists* offers "practical" advice on surviving in outer space—at least in the sense of what to expect based on facts available today. Although space travel is still in its infancy, several efforts are underway to make space tourism a reality. In 50 years or so, weekend getaways aboard the Space Shuttle may be commonplace. In the meantime, you can prepare for a future vacation by reading the *Handbook for Space Colonists*. ■

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BOOK BRIEFS

Logo

Explorer's Guide to Apple Logo by Joan Webb, Peter von Mertens, and Maggie Holmes. Hayden Books, 10 Mulholland Dr., Hasbrouck Heights, NJ 07604. Softcover, 256 pages, $12.95

This introductory guide teaches children how to program Krell and Terrapin Logo on the Apple computer. Classroom editions, including teacher's manual and review sets, are available.

CoCo Logo by Dale Peterson, Don Inman, and Ramon Zamora. Wiley Press, 605 Third Ave., New York, NY 10158. Softcover, 127 pages, $12.95

This introduction to Color Logo for the TRS-80 Color Computer provides several examples and sample programs.

Beyond Mindstorms: Teaching with IBM Logo by Joyce Tobias, Sharon Burrowes, Jerry Short, and Tom Lough. Holt, Rinehart, and Winston. Softcover, 431 pages, $21.95

Written for teachers, this book shows how to develop Logo graphics while incorporating arithmetic, words, and lists. Numerous sample programs serve as excellent programming examples.

Learning With Apple Logo by Daniel Watt. McGraw-Hill. Softcover, 322 pages, $19.95

This thick book overflows with projects to help kids learn Apple Logo. Editions for Krell Logo and Terrapin Logo are also available.

The Second Logo Book by Dan Weston. Scott, Foresman and Co. Softcover, 219 pages, $12.95

Subtitled "Advanced Techniques in Logo," this guide explores other aspects of Apple Logo and DR. Logo, including programs using words, lists, and numbers.

Mathematics and Logo by Kathleen Martin and Donna Bearden. Reston Publishing, Reston, VA 22090. Softcover, 163 pages, $19.95

Subtitled "A Turtle Trip Through Geometry," this rather overpriced book offers Logo instruction involving angles, circles, and spacial relationships.

Learning Logo on the TRS-80 Color Computer by Tony Adams, Pauline Adams, and Anne McDougall. Prentice-Hall. Softcover, 174 pages, $12.95

This introduction to Logo programming for TRS-80 Color Computer owners holds a potpourri of sample programs and other engaging turtle activities.

Education

Microcomputers and Exceptional Children, edited by Randy E. Bennett and Charles A. Maher. The Haworth Press, 28 22nd St., New York, NY 10010. Hardcover, 113 pages, $19.95

This collection of papers written by educators examines how microcomputers are assisting special education programs in schools. Although pricey, the book provides valuable information and extensive reference sections.

Computers In Education by Bobbie K. Hentrel, and Linda Harper. University of Michigan Press, Ann Arbor, MI 48109. Softcover, 110 pages, $7.95

This book details how an elementary school in Michigan implemented a computer literacy program. It includes an extensive listing of recommended educational software used by the school.

Computers in Early and Primary Education by Douglas H. Clements. Prentice-Hall. Softcover, 322 pages, $16.95

This rather extensive book discusses the educational principles behind using computers, reviews relevant research, and includes numerous tables, charts, and illustrations. All in all, it is well worth a look.

Computers in Schools by William J. Bramble and Emanual J. Mason. McGraw-Hill. Softcover, 334 pages, $16.95

This introduction to using computers in education examines the technology, offers advice on installing systems, and provides general reference sections. Although not the most dynamic material, the information should be a help to educators who know absolutely nothing about microcomputers.

Educational Microcomputing Annual edited by John H. Tashner. Oryx Press, 2214 N. Central at Encato, Phoenix, AZ 85004. Softcover, 184 pages, $24.50

This collection of reprinted articles

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APPLE IIe IIc (128K, 80-Column Monitor, Two Drives) from computer and education magazines covers philosophical questions, trends, hardware, software, and integrating computers into the curriculum.

Personal Computers for Education by Alfred Bork. Harper & Row. Softcover, 179 pages, $19.95

Dr. Alfred Bork, director of the Educational Technology Center for the University of California at Irvine, explores the role of computers in educational institutions. He discusses how computers should be used in teaching, covers hardware and software, and predicts future developments in educational computing.

Help for Parents

The Parents' Computer Book by M. David Stone. Macmillan Publishing. Softcover, 288 pages, $16.95

In pleasant, non-technical prose, M. David Stone holds parents by the hand and leads them into the world of microcomputers. Unlike most introductory books, he does not dwell on hardware and software, but rather focuses on the physical and psychological effects of computer use. He explores the pros and cons of programming, discusses video games and more practical applications, and includes a fairly extensive reference section. For the computer illiterate parent, this book is worth the price.

Coming of Age in the Land of Computers by Edward Yourdon. Prentice-Hall. Softcover, 167 pages, $16.95

This book provides mediocre information about computers for your child. While it does a passable job explaining computer hardware, its suggestion of purchasing the Timex Sinclair 1000, TI 99/4, Atari 400, and Vic 20 is at best out of date and at worst ludicrous. The section on computer careers is fairly well done, but software seems to be almost completely ignored. Our best advice: spend your $16.95 on something else.

A Guide to Computer-Age Parenting by Peter Scharf. McGraw-Hill. Softcover, 234 pages, $9.95

Associate Professor of Sociology Peter Scharf offers sage advice for teaching children about computing. He examines parental values, suggests family activities, discusses computer skills, and includes 50 reviews of the "best" educational software packages. This is a commendable effort. ■

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Quite something for nearly nothing/**John J. Anderson**

Mark Twain in his 76 productive years missed out on at least one special treat: he never got to see Comet Halley. It appeared in 1835, the year he was born, and again in 1910, the year he died. His only solace was to have predicted it would be so—small solace though that might have been. We are luckier, for 1986 is another year for Comet Halley, constituting a true once-in-a-lifetime event.

Royal Astronomer Edmund Halley indeed observed the comet, though when he did so in 1682, it did not bear his, or any name at all. Its return was spotted 76 years later by amateur astronomer George Palitzch, Christmas night 1758, just as Halley had predicted. And so it was dubbed Halley's, perhaps to the chagrin of Mr. Palitzch. One can only speculate how Halley himself felt about this, having been dead for 17 years.

Since the beginning of recorded history, the comet that came to be called Halley's has been observed. The Chinese recorded its appearance in 1057 B.C. and were the first to note that the tail of such a body always points away from the sun. It has formed the basis of many a kingly vision and perhaps even of the Star of Bethlehem. The comet appeared in the auspicious year 1066 and is depicted alongside William the Conquerer in the Bayeux Tapestry. Comets have consistently raised more fear and superstition among skittish humans than any other type of celestial body. They have been thought to portend deadly events—even to spread poisonous vapors into the atmosphere. The latter has been scientifically disproved.

It was Halley who conceived that the bodies observed in 1531, 1607, and 1682, were indeed one and the same, a bright comet in an elliptical orbit with a period of approximately 76 years. He further theorized that the somewhat erratic timing of its flybys was due to perturbations among the Jovian planets. Although he contributed much more to the astronomical knowledge of his day, it is for these calculations that he is remembered today.

Dig Newton

Edmund Halley was a most interesting gentleman. He published his first astronomical paper at the age of 20. More significantly, he happened to be close buddies with a certain Isaac Newton—and his greatest fan. It is probable that the publication of Newton's classic work *Principia Mathematica* was Halley's own idea, as he helped Newton collect the data, oversaw the printing, and in fact bankrolled the book. Much of the material within it concerning comets is almost certainly Halley's own, although that work is entirely derived from that of Newton.

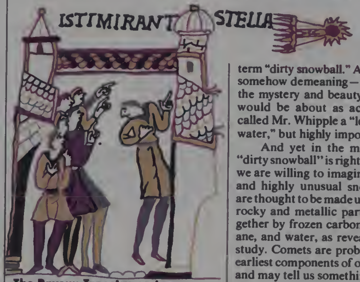
Newton came up (or perhaps down) with the idea of gravitation and went as far as to say that the laws of motion caused heavenly bodies to orbit one another. At the time, this was indeed a radical assertion: Christiaan Huygens, master telescope craftsman and astronomer, dismissed Newton's work as "absurd." But Halley's faith in Newton was unflappable, and he extended the theory to explain the periodicity of comets.

Halley's friendship with Newton did not always serve him well. When, in 1720, he was named chief astronomer of the Royal Society, he arrived to find the Royal Observatory largely cleared of instruments. His predecessor, John Flamsteed, who had clashed with Newton more than once in the past, claimed most of it was his own property and had taken the best of the lab with him. Flamsteed's heirs and creditors also got an early shot at the remnants. Halley managed to obtain some new instruments, but never made another significant contribution to the field.

On Comet

And this intermittent cosmic visitor itself—exactly what is it? Perhaps the greatest disservice done to this question can be pinned upon a modern astronomer by the innocuous name of Fred Whipple. Fred gave us the cometary term "dirty snowball." Accurate, yes, but somehow demeaning—it strips away all the mystery and beauty of the thing. It would be about as accurate to have called Mr. Whipple a "leaky bag of dirty water," but highly impolite at best.

And yet in the most basic sense, "dirty snowball" is right on the money, if we are willing to imagine a rather large and highly unusual snowball. Comets are thought to be made up of a mixture of rocky and metallic particles bound together by frozen carbon dioxide, methane, and water, as revealed by spectral study. Comets are probably among the earliest components of our solar system, and may tell us something about its origins. It should be remembered that like planets as opposed to stars, comets emit



The Bayeux Tapestry portrays 1066 sighting.

no light of their own. Rather they reflect the light of the sun.

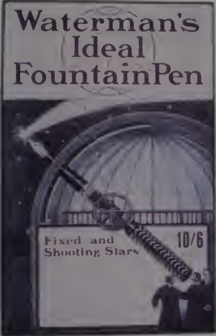
Around the snowball "nucleus," which may or may not itself be visible, glows the *coma* of a comet. The coma is the pseudo-atmosphere of gas and dust pried loose from its surface by radiation and rotation. Together, the nucleus and coma form the *head* of the comet. Although the nucleus of a comet may be only a few kilometers across, its coma can be very large—perhaps upwards of 150,000 kilometers. The coma itself is very diffuse. Stars were observed shining brightly through the outer coma of Comet Halley during its visit in 1910. At that time, Comet Halley came between the earth and sun, yet no opaque nucleus was observable in silhouette. The resolution of instruments used indicates the nucleus of the comet itself to be less than 50 km across (astronomer Carl Sagan guesses it to be approximately 20 km). Whether comet nuclei are solid or a loose aggregation of particles remains to be discovered, but it has been recently established that they, like other heavenly bodies, rotate about a central axis.

Thereby Hangs a Tail

The most celebrated aspect of any comet, of course, is its tail. The tail is caused by solar radiation and solar wind. Most comets produce a tail only as they cross within 2 A.U. (astronomical units, one of which equals the distance to the sun from good old planet earth, or about 150 million km) of the sun. At that distance and closer, the radiation of the sun begins to shear the comet. Comets actually have two tails, though one is frequently consumed by the path of the other. Solar wind causes a gaseous tail, which always points directly perpendicular to the sun. Solar radiation causes a dust tail, made up of relatively large particles, which tends to lag behind the gaseous tail and curve in the direction of orbit. The tail of a comet may be huge—more than 160 million km, or greater than one A.U. in length.

And so, like a piece of chalk pulled across a celestial sidewalk, periodic comets expend themselves with each solar orbit. They suffer the erosion not only of solar radiation but of solar tidal forces. It is estimated that few periodic comets survive more than 100 or so orbits. In 1842, a comet known as Biela was observed to split in two as it rounded the sun. Comet Halley is quite hale, however, and is probably good for at least 60,000 more orbits, so don't fret.

After one has asked what, quite literally, in heaven a comet is, the next natural question is "Where does it come from?" The contemporary Dutch astronomer Jan Oort has posited that a "cloud" of cometary material surrounds the solar system at a distance of approximately 100,000 A.U. If this material actually comprises the basic goo of celestial matter, most of it congealed into the solar system around the gravitation of the sun, bringing us our own planet in the process of the creation of the universe. That which escaped such compression continues to halo the solar system, beyond the reach of its gravitational forces, save for the occasional straggler swung into periodic orbit. Oort estimates that there are more than 100 billion of them residing in the cloud, yet with a combined mass of less than 0.1 that of earth.



Wide World Magazine, 1910.

So it becomes clear why it has been said that comets are "the nearest thing to nothing that anything can be and still be something." In fact, the tail of a comet contains less matter than the best vacuum scientists can create on earth. Yet these wisps of near nothingness have captured man's imagination throughout history, and in 1986, the reappearance of Comet Halley has focused an international scientific effort.

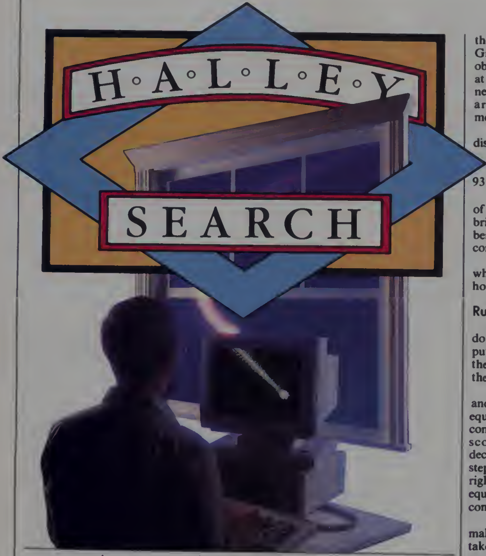
No fewer than five space probes are slated to study Halley's Comet. The Soviets have already launched two craft bearing mass spectrometers, which will fly by at 10,000 km from the comet. A European probe is planned to pass within a mere several hundred km of it. The Japanese have designed two space vehicles of their own. Shamefully, the U.S. has planned no dedicated probe, as a result of the NASA budget crunch (see accompanying article). However a shuttle mission will carry special instruments for comet watching outside the obfuscating atmosphere of planet earth.

The Halley Search program (page 28) will help you locate Comet Halley in your local sky at your local time. Using a halfway decent telescope on a clear night, you will definitely be able to spot it. Don't be disappointed, however, if it is no more impressive than a star or a bright planet. This time around the comet will pass only within 39 million miles of the earth, which is farther away than it has been on previous trips (in the year 837, it passed by at a distance of only 3.7 million miles and was for a time visible in broad daylight). Depending on the date, time, and weather, you may or may not be able to spot the wisp of tail that makes Comet Halley so special. If you are in the Southern Hemisphere, you will have a better view.

In his book *Cosmos*, Sagan quotes from a work called "Theological Reminder of a New Comet," by Andreas Celichius: "[A comet is] the thick smoke of human sins, rising every day, every hour, every moment, full of stench and horror before the face of God, and becoming gradually so thick as to form a comet, with curled and plaited tresses, which at last is kindled by the hot and fiery anger of the Supreme Heavenly Judge." Sagan presents a piquant counter to this theory, positing that "if comets were the smoke of sin, the skies would be continually ablaze with them."

1910 advertisement from *The Graphic*.

I'm not sure, but I think that may be a comforting thought. ■



Halley Search

A program to help you find the Comet

Harald Schenk and John J. Anderson

As Halley's Comet passes through our solar system, many readers of *Creative Computing* may miss a chance to see it simply because they do not know where to look. Add two other factors—that the comet will not be as bright as it was in 1910 and "light pollution" (especially in urban areas) may obscure it—and you may be left out of the comet craze completely.

To help our readers who share our fascination with space, we present a Basic program, Halley Search, to guide you in locating the famous comet. In exchange for the current date, the program will reveal the following information:

- Location in terms of right ascension and declination.
- Distance from the Sun and Earth in astronomical units.
- Magnitude.
- Rising and setting times.

Because novice astronomers may be unfamiliar with some of the terms used in the output, we offer some brief definitions and take a look at how they relate to the program.

Right Ascension and Declination are coordinates for measuring the position of an object in the sky. In a way, they are like the X and Y coordinates used to locate a point on a graph. Right ascension provides the east-west position (the X coordinate) and declination provides the north-south position (the Y coordinate). Right ascension is measured in hours and declination is measured in degrees.

Universal Time (UT), a standard measurement of time for astronomers, is the time in Greenwich, England. Why Greenwich? Well, a large number of observations of star positions were made at the Royal Greenwich Observatory near London, and that place was selected arbitrarily as the starting point for measuring longitude.

Astronomical Units (AU) measure distances within our solar system. 1 AU equals the distance between the Earth and the Sun, or approximately 93 million miles.

Magnitude refers to the brightness of the comet. The lower the number, the brighter the object. The higher the number, the greater the need to view the comet through binoculars or a telescope.

Rising and Setting Times tell you when the comet is visible above the horizon.

Running Halley Search

To run the program, all you have to do is specify whether you want the output in Daylight or Standard time and then enter the date. The program returns the necessary information.

Figure 1 lists various magnitudes and should give you an idea of what equipment you will need to see the comet. So grab your binoculars or telescope, plot the right ascension and declination on the sky map (Figure 2), step outside, and take a look. Under the right conditions and with the proper equipment, you too can view the famous comet.

Please allow the program time to make the calculations. The process can take several minutes, especially if you are running Halley Search on an Atari.

You may also enter historical dates. For example, Halley's Comet last appeared in 1910. You might want to check the differences in location between appearances.

But Does It Play in Peoria?

The program is set for New York City latitude and longitude. Your latitude and longitude is probably different, so your rising and setting times will also be different.

To localize the program for your area, run the customization utility program in Listing 1, take the results, and make the substitutions in the main program (Listing 2).

Those of you who want to do the trigonometry instead of letting the customization program do it for you should perform the following steps:

Convert latitude degrees into radians by dividing your latitude by 57.2958.

Take the SIN of this number, find line 720, and put it in place of 0.656059. Next, take the COS of the number, find line 720, and put it in place of 0.754710.

Take your longitude, subtract 75 if you are in the Eastern Standard Time zone, 90 if you are in the Central Standard Time zone, 105 if you are in the Mountain Standard Time zone, or 120 if you are in the Pacific Standard Time zone. Multiply this number by 0.066666, and substitute the result for −.066666 in lines 770 and 780.

If you are in the Central, Mountain, or Pacific time zone, remember to replace the word Eastern in lines 820 and 870 with your appropriate time zone.

Finally, replace the number −1 in line 1320 with 0 (if you are in the Central zone), 1 (if you are in the Mountain zone), or 2 (if you are in the Pacific zone).

You can find your latitude and longitude in any atlas. For those who do not need pinpoint accuracy, we include them for selected cities in Figure 3.

All three versions of Halley Search (in Atari, Commodore, and Microsoft Basic), as well as the customization program (runs with just about all dialects of Basic), are available on CompuServe in the *Creative Computing* SIG (go PCS-22). If you have a modem and CompuServe account, you can save some typing by downloading the programs from our SIG.

Space, the Final Frontier

We wish you good hunting in your search for Halley's Comet. We suggest you try to find an area as devoid of artificial light as possible. If you miss Halley's Comet this year, you can always try again later—about the year 2060. ■

City	Latitude	Longitude
Albuquerque, NM	35	107
Boston, MA	42	71
Boulder, CO	40	105
Buffalo, NY	43	79
Chicago, IL	42	88
Dallas, TX	33	97
Los Angeles, CA	34	118
Miami, FL	26	80
Minneapolis, MN	45	93
New York, NY	41	74
Philadelphia, PA	40	75
Phoenix, AZ	33	112
St. Louis, MO	39	90
Salt Lake City, UT	41	112
San Francisco, CA	38	122
Seattle, WA	48	122
Washington, DC	39	77

Figure 3. Latitude and longitude for selected cities.

-2 SIRIUS
-1
0
1
2 POLARIS
3 NAKED EYE LIMIT (IN CITIES)
4
5 LIMIT (AVERAGE CONDITIONS)
6 LIMIT (GOOD CONDITIONS)
7
8
9 LIMIT (7x50 BINOCULARS)
10 LIMIT (2" TELESCOPE)
11 LIMIT (3" TELESCOPE)
12

Figure 1. Comparative visibilities of stellar magnitudes.

MERCURY 0.3871 A.U.

VENUS 0.7233

EARTH 1.0000

MARS 1.5237

JUPITER 5.2028

Figure 4. Planetary distances measured in Astronomical Units.

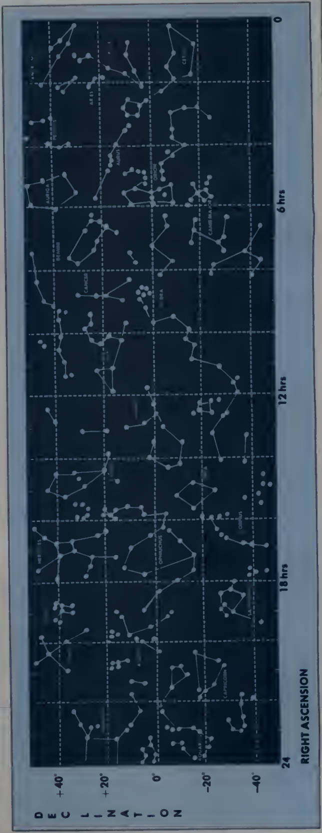
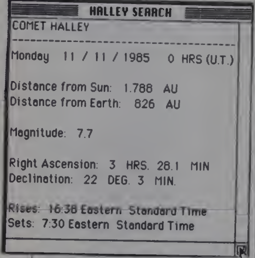


Figure 2. Sky chart for use with program output. Cross index the right ascension coordinate with the declination coordinate; their intersection pinpoints Halley's Comet.



Sample run.

Halley search tailored for your microcomputer.

To enter this listing for the CBM, C64, C128, or expanded VIC:

Replace the command CLS with the statement PRINT CHR$(147) in lines 10 and 150.

To enter this listing for the Atari 400, 800, XL and XE series:

1. Type the fallowing new line:
```
9 CLR:DIM T$(10),P$(20),D$(60),W$
  (20),H$(10),M$(10),Z$(10):Z$="0"
```
2. Replace the cammand CLS with the statement PRINT CHR$(125) in line 10.
3. Remave the quatatian marks fram "COMET HALLEY" in line 80.
4. Replace line 150 with the fallowing:
```
150 W$=D$(9*(F-INT(F/7)*7)+1,9*
  (F-INT(F/7)*7)+9) PRINT CHR$(125)
```
5. Replace line 1010 with the fallowing:
```
1010 U=SQR(1-E*E)*(SIN(K/2)/COS
     (K/2))/(1+E)
```
6. Replace line 1510 with the fallowing:
```
1510 M$=STR$(M)
```
7. Replace line 1520 with the fallowing:
```
1520 IF LEN(M$)<2 THEN M$(LEN(M$
     )+1)=Z$
```

To enter this listing for the Tandy Model 100, NEC 8201, or Olivetti M-10:

1. Delete line 170.
2. Remave stand-alone print statements in lines 180, 370, and 630.

Listing 1.

```
1 REM -- HALLEY SEARCH CUSTOMIZER --
2 REM Program by John J. Anderson (c) 1985 Creative Computing
3 REM THIS PROGRAM RUNS ON ALL MICROS LISTED FOR HALLEY SEARCH
4 REM If you find typing preferable to trigonometry, use this program
5 REM to calculate all the custom alterations that will tailor the
6 REM program HALLEY SEARCH to your locale. You must still know the
7 REM LATITUDE and LONGITUDE of your location in order to use this
8 REM program. If you are not near a city listed in our accompanying
9 REM chart, check an atlas at your local library for exact coordinates.
10 PRINT"ENTER YOUR LATITUDE:  ";:INPUT X
20 PRINT"ENTER YOUR LONGITUDE: ";:INPUT Y
30 PRINT"ENTER YOUR TIME ZONE:"
40 PRINT"(1) EASTERN"
50 PRINT"(2) CENTRAL"
60 PRINT"(3) MOUNTAIN"
70 PRINT"(4) PACIFIC ":INPUT Z
80 IF Z=1 THEN Z=75
90 IF Z=2 THEN GOSUB 210
100 IF Z=3 THEN GOSUB 250
110 IF Z=4 THEN GOSUB 290
120 X=X/57.2958
130 PRINT"REPLACE THE VALUE .656059 WITH ";SIN(X);" IN LINE 720."
140 PRINT"REPLACE THE VALUE .754710 WITH ";COS(X);" IN LINE 720."
150 Y=(Y-Z)*.0666666
160 PRINT"REPLACE THE VALUE -.066666 WITH THE VALUE ";Y
170 PRINT"IN LINES 770 AND 780."
180 IF Y>0 THEN PRINT"USE A '+' SIGN TO ADD THE VALUE TO H";
190 IF Y<0 THEN PRINT"USE A '-' SIGN TO SUBTRACT THE VALUE FROM H";
200 PRINT" IN LINES 770 AND 780.":END
210 Z=90:PRINT"REPLACE THE WORD 'EASTERN' WITH 'CENTRAL' IN"
220 PRINT"LINES 820 AND 870."
230 PRINT"REPLACE THE VALUE -1 WITH 0 IN LINE 1320."
240 RETURN
250 Z=105:PRINT"REPLACE THE WORD 'EASTERN' WITH 'MOUNTAIN' IN"
260 PRINT"LINES 820 AND 870."
270 PRINT"REPLACE THE VALUE -1 WITH 1 IN LINE 1320."
280 RETURN
290 Z=120:PRINT"REPLACE THE WORD 'EASTERN' WITH 'PACIFIC' IN"
300 PRINT"LINES 820 AND 870."
310 PRINT"REPLACE THE VALUE -1 WITH 2 IN LINE 1320."
320 RETURN
```

Listing 2. The Halley Search program.

```
1 REM -- HALLEY SEARCH --
2 REM Original program by Harald Schenk and John Port
3 REM Version 3.6 by John J. Anderson
4 REM (c) 1985 Creative Computing Magazine
5 REM This version runs without alteration on Macintosh, IBM, Tandy desktops.
6 REM Color Computer requires print format changes only.
7 REM For Atari, Commodore 64, 128, CBM, Expanded Vic, Tandy Model 100, NEC
8 REM 8201 and Olivetti M-10, see accompanying figure for amendments
10 CLS:PRINT "Daylight or Standard Time (D/S)";:INPUT T$:PRINT
15 IF T$="D" OR T$="d" THEN T5=13:T$=" Daylight":GOTO 30
20 IF T$="S" OR T$="s" THEN T5=12:T$=" Standard":GOTO 30
25 GOTO 10
30 PRINT"Month ---------(1-12)";:INPUT M:IF M<1 OR M>12 THEN GOTO 30
40 PRINT"Day -----------(1-31)";:INPUT D:IF D<1 OR D>31 THEN GOTO 40
50 PRINT"Year ---(in entirety)";:INPUT Y:IF Y<0 THEN GOTO 50
60 READ A,E,P,I,N,L,F1,F2,M1,M2,M3,P$
70 DATA 17.9435,.967267,27762.4,2.8316,1.014827,2.96725,725412,.144
80 DATA 4.6,14,5,"COMET HALLEY",1,.01672,365.2564,0,0,721356,.5385
90 MO=M:YO=Y:DO=D
100 REM Finds Number for date entered and day of week
110 IF M>2 THEN 130
120 F=365*Y+INT(D)+31*(M-1)+INT((Y-1)/4)-INT(3/4*INT((Y-1)/100+1)):GOTO 140
130 F=365*Y+INT(D)+31*(M-1)-INT(.4*M+2.3)+INT(Y/4)-INT(3/4*INT(Y/100+1))
140 D$="Saturday Sunday   Monday   Tuesday  WednesdayThursday Friday   "
150 W$=MID$(D$,9*(F-INT(F/7)*7)+1,9):CLS
160 REM Prints Heading
170 PRINT P$:PRINT "-----------------------------------"
```

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Listing 2. *(continued)*

```
180 PRINT W$;" ";M0;"/";INT(D0);"/";Y0; " ";(D0-INT(D0))*24;
    "HRS (U.T.)":PRINT
190 F0=F:D0=D0-INT(D0)
200 IF F0>725411 THEN M2=5.5
210 GOSUB 900
220 GOSUB 1120
230 X2=X:Y2=Y:Z2=Z
240 GOSUB 1340
250 PRINT"Distance from Sun: ",R/1000;" AU"
260 M9=M1+M2*LOG(R/1000)/LOG(10)
270 REM Read Orbital Elements for Earth
280 READ R,E,P,I,N,F1,F2
290 L=1.79065+.000244*(Y0+(M0-1)/12-1980)
300 GOSUB 900
310 GOSUB 1120
320 X1=X:Y1=Y:Z1=Z
330 GOSUB 1340
340 X3=X2-X1:Y3=Y2-Y1:Z3=Z2-Z1
350 R=SQR(X3*X3+Y3*Y3+Z3*Z3)*1000
360 GOSUB 1340
370 PRINT"Distance from Earth: ";R/1000;" AU":PRINT
380 R=10*(M9+M3*LOG(R/1000)/LOG(10)):GOSUB 1340
390 PRINT "Magnitude: ";R/10:PRINT
400 REM Find Right Ascension (A) and Declination (D1)
410 Q=1: IF X3<0 THEN Q=-1
420 U=1.5708-Q*ATN(Y3/X3)
430 S=Z3/SQR(X3*X3+Y3*Y3+Z3*Z3)
440 IF ABS(S+1)<.000001 THEN I=-1.5708:GOTO 470
450 IF ABS(S-1)<.000001 THEN I=1 5708:GOTO 470
460 I=ATN(S/SQR(1-S*S))
470 T=1.5708-I:C=.917465*COS(T)+ 397817*SIN(T)*COS(U)
480 GOSUB 1390
490 D1=1.5708-I
500 C=(COS(T)-.917465*COS(I))/(.397817*SIN(I))
510 GOSUB 1390
520 A=18+Q*I*24/6.28318.A1=A
530 GOSUB 1270
540 PRINT"Right Ascension: ";H;" HRS.";M," MIN."
550 REM Converts Declination for Display
560 H=D1*57.2958
570 R=(ABS(H)-INT(ABS(H)))*60
580 GOSUB 1340
590 M=R:H=INT(H):IF H<0 THEN H=H+1
600 IF M=60 AND H>=0 THEN H=H+1:M=0
610 IF M=60 AND H<0 THEN H=H-1:M=0
620 IF H=0 THEN M=M*SGN(D1)
630 PRINT "Declination: ";H;" DEG.";M;" MIN.":PRINT
640 E0=(F0-722894-.2236+D0)*.0172028*24/6.28318-.123333
650 IF ABS(E0)>=24 THEN E0=E0-SGN(E0)*24
660 IF ABS(E0)>=24 THEN 650
670 IF E0<0 THEN E0=E0+24
680 IF A1>=24 THEN A1=A1-24
690 T0=T5+A1-E0
700 IF T0>=24 THEN T0=T0-24
710 IF T0<0 THEN T0=T0+24
720 H=(-.00995-COS(1.5708-D1)*.656059)/(SIN(1.5708-D1)*.754710)
730 IF H<=-1 THEN PRINT"Halley is Above Horizon All Day."
    :GOTO 1540
740 IF H>=1 THEN PRINT"Halley is Below Horizon All Day."
    :GOTO 1540
750 C=H:GOSUB 1390
760 H=I/6.28318*24
770 A=T0-H-.066666
780 S=T0+H-.066666
790 IF A<0 THEN A=A+24
800 GOSUB 1270
810 GOSUB 1470
820 PRINT"Rises: ";H$;":";M$;"Eastern ";T$;" Time"
830 A=S:IF A<0 THEN A=A+24
840 IF A>=24 THEN A=A-24
850 GOSUB 1270
860 GOSUB 1470
870 PRINT "Sets: ";H$;":";M$;"Eastern ";T$;" Time"
890 END
900 REM Finds Orbital Motion Since Perihelion
910 A5=3.14159*A*SQR(A*A*(1-E*E))
920 A0=A5*(F0-F1-F2+D0)/P
930 IF ABS(A0)>A5 THEN A0=A0-SGN(A0)*A5
940 IF ABS(A0)>A5 THEN 930
950 IF A0<0 THEN A0=A0+A5
960 A=A*A*(1-E*E)*(1-E*E)/2
970 T=2/((E*E-1)*SQR(1-E*E))
980 K1=3.14159:K=3.14159
990 K1=K1/2
1000 S=E*SIN(K)/((E*E-1)*(1+E*COS(K)))
1010 U=SQR(1-E*E)*TAN(K/2)/(1+E)
1020 V=ATN(U)
1030 IF U<=0 AND K>3.14159 THEN V=V+3.14159
1040 A1=A*(S-T*V)
1050 IF K>6.28318 THEN A1=A1+(3.14159*A*SQR(A*A*
     (1-E*E)))
1060 IF K1<.000001 THEN 1090
1070 IF A1<A0 THEN K=K+K1:GOTO 990
1080 IF A1>A0 THEN K=K-K1:GOTO 990
1090 IF K=6.28318 THEN K=0
1100 R0=A*(1-E*E)/(1+E*COS(K))
1110 RETURN
1120 REM Computes (X,Y,Z) Coordinates
1130 A1=L-N+K
1140 IF A1>6.28318 THEN A1=A1-6 28318
1150 IF A1>3.14159 THEN A1=A1-6.28318
1160 Q=1.IF A1<0 THEN Q=-1
1170 C=SIN(A1)*COS(1.5708-I).IF I>1.5708 THEN Q=-Q
1180 GOSUB 1390
1190 A2=I
1200 C=COS(A1)/SIN(A2)
1210 GOSUB 1390
1220 Z=R0*SIN(1.5708-A2)
1230 Y=R0*COS(1.5708-A2)*SIN(N+Q*I)
1240 X=R0*COS(1.5708-A2)*COS(N+Q*I)
1250 R=SQR(X*X+Y*Y+Z*Z)*1000
1260 RETURN
1270 REM Converts R.A. For Display
1275 A1=A
1280 H=A:A=(H-INT(H))*600
1290 GOSUB 1340
1300 M=R/10
1310 IF M=60 THEN H=H+1:IF M=60 THEN M=0
1320 K1=-1:H=INT(H):H=H+K1:IF H>24 THEN H=H-24
1330 RETURN
1340 REM Rounds to the Nearest Integer
1350 R9=R-INT(R)
1360 IF R9>=.5 THEN R=R+1
1370 R=INT(R)
1380 RETURN
1390 REM Inverse Cosine Subroutine
1400 IF ABS(C-0)< 000001 THEN I=3.14159/2:RETURN
1410 IF ABS(C-1)< 000001 THEN I=0:RETURN
1420 IF ABS(C+1)<.000001 THEN I=3.14159 RETURN
1430 I=ATN(SQR(1-C*C)/C)
1440 IF I=0 THEN I=3.14159/2 RETURN
1450 IF C<0 THEN I=I+3.14159
1460 RETURN
1470 REM Converts Hours and Minutes to String$
1480 R=M:GOSUB 1340
1490 M=R:IF M=60 THEN H=H+1  IF M=60 THEN M=0
1500 H$=STR$(H)
1510 M$=RIGHT$(STR$(M),LEN(STR$(M))-1)
1520 IF LEN(M$)<2 THEN M$="0"+M$
1530 RETURN
1540 END
```

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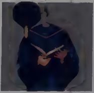

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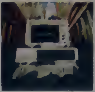

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CELESTIAL SOFTWARE

Peer into the heavens, track Halley's Comet, and learn about the universe/**Russ Lockwood**

As Halley Comet fever heats up, we have been seeing an increasing number of ads for telescopes, T-shirts, tours, and, yes, even some computer packages. Although we would like to evaluate some of the tours, we decided it made more sense to take a critical look at an assortment of astronomy software packages. This area of software generally continues in the hobbyist tradition, with plastic bag packaging, typewritten documentation, and very little marketing prowess. For the most part, the programs offer information on scanning the nighttime sky, plotting the movement of Halley's Comet, picking out constellations, and locating other deep space objects. You do not need a degree in astronomy to appreciate the programs, although you should be able to input longitude and latitude for your area. Many of the programs provide precise coordinates for telescope-wielding amateur astronomers.

To select the package that is right for you, read through our capsule descriptions, pick a few that interest you, and either write or call the company for more complete information (don't forget to tell them you saw the product in *Creative*).

Astro Series and Cometwatch

Astroaid provides time/distance conversions for the serious astronomer and dedicated amateur astronomer. The documentation lists the Basic program.

Astrobase finds 300 deep sky objects in space. You can use it as a logbook and add objects to the database.

Astrocalc computes the basic astronomical data for the sun, moon, and planets. This hard core data is for the serious astronomer only. The documentation lists the Basic program.

Astrostell, the newest Basic program in the line, lists and plots 88 constellations. Unfortunately, it may be a bit too new, for in our copy, the text files were fine, but the plot portion of the program registered illegal function calls at line 3260 and 9008.

Cometwatch provides information about Halley's Comet, including orbit, composition, and when to look. It is functional but not spectacular.

System and Price: 64K IBM PC, Apple II, C64, C128; $31.95 each

Manufacturer:
Zephyr Services
306 S. Homewood Ave.
Pittsburgh, PA 15208
(412) 247-5915

Astronomy: Stars for All Seasons

Geared for grades 5 through 12, *Astronomy* plots 34 constellations in the sky and lets students observe seasonal changes. It is generally good, sometimes uneven, and a bit pricey.

System and Price: Apple II, C64, TRS-80 Model III and 4; $59.95

Manufacturer:
Educational Activities
1937 Grand Ave.
Baldwin, NY 11510
(516) 223-4666

Celestial Basic

This compilation of programs from the book of the same name by Eric Burgess, Fellow of the Royal Astronomical Society, provides programs to calculate moon and planetary information. A second disk holds time conversion, plot guide, and other assorted Basic programs for astronomers.

System and Price: Apple II, C64, Timex 2068; $29.95 per disk, $49.95 for both disks.

Manufacturer:
S&T Software
13361 Frati Ln.
Sebastopol, CA 95472
(707) 874-2352

Eclipse Map, Planetarium, and World Map

Eclipse Map shows you the best spot from which to view a solar eclipse. The program draws a map of the world and places a line to mark the passage of the sun and moon.

Planetarium is an unsophisticated sky display program that takes 15 minutes to load on the Apple. Pass this one right by.

World Map draws a map of the world, divides it into day and night, and plots the movements of the sun and moon. It is not bad if you need this information.

System and Price: Apple II, C64; $23-$30

Manufacturer:
Charles Kluepfel
11 George St.
Bloomfield, NJ 07003

Halley

This is a really nice program for tracking Halley's Comet. The graphics display plots the path of the comet through the solar system (heliocentric) and from the ground (geocentric). It provides the coordinates for comet watchers and prints out maps.

System and Price: 64K IBM PC; $36.95

Manufacturer:
StarSoft
P.O. Box 2524
San Anselmo, CA 94960
(415) 456-1308

Halley's Comet

One of the better programs we reviewed, *Halley's Comet* by Eric Burgess, Fellow of the Royal Astronomical Society, finds and plots the famous comet among the stars. It provides a wealth of information.

System and Price: IBM PC, TI Pro, C64, Timex 2068; $49.95

Manufacturer:
S&T Software
13361 Frati Ln.
Sebastopol, CA 95472
(707) 874-2352

Journey To The Stars

Unlike other programs, which confine your viewing area to roughly half to two-thirds of the screen, *Journey To The Stars* uses the entire screen to display 48 constellations and 42 major stars against the background of 1400 stars. It is an excellent "view-oriented" program.

System and Price: 96K IBM PC; $60

Manufacturer:
COMPress
P.O. Box 102
Wentworth, NH 03282
(603) 764-5831

Planet Probe

A fairly interesting arcade-style space game requires players to demonstrate knowledge about planets.

System and Price: C64; $17.95

Manufacturer:
MicroEd
P.O. Box 44405
Eden Prairie, MN 55344
(612) 944-8750
(800) MICROED

Public Domain Software

This series of five public domain programs is just the thing for those who want to take a low-cost look into astronomy. *Constellations* plots 30 of the brightest constellations. *Astro Conversions* converts azimuth coordinates to right ascension and declination. *Sunrise* calculates time of sunrise and sunset on any date anywhere in the world. *Phases* draws the phases of the moon (no craters) on any date. *Planet Show*, a very nice slide-show of the planets, displays an artistic rendition of images returned from planetary probes. And you can't beat the price.

System and Price: Apple II; $1 plus 5.25" disk

Manufacturer:
Ron Dawes
882 Chestnut Circle
Wright-Patterson AFB, OH 45433

Saturn Navigator

An older program (circa 1982), *Saturn Navigator* is designed by Wes Huntress of the Jet Propulsion Lab. It shows how spacecraft are maneuvered by letting you navigate from Earth to Saturn. It is rather complex, presents many technical concepts, and displays good graphics. Although not terribly exciting, it is somewhat interesting and challenging.

System and Price: 48K Apple II+; $34.95

Manufacturer:
Sublogic
713 Edgebrook Dr.
Champaign, IL 61820
(217) 359-8482

Sky Travel

This home planetarium for your C64 finds and tracks constellations, planets, and other celestial objects. The text holds mostly dry facts, and you can print out the contents of the screen. The documentation is an excellent introduction to astronomy. *Sky Travel* is a very fine package.

System and Price: C64; $49.95

Manufacturer:
Commodore Business Machines
1200 Wilson Dr.
West Chester, PA 19380
(215) 431-9100

Solar System Astronomy

Although the program claims to be geared for high school and college students, the rudimentary information within is better suited to third graders. *Solar System Astronomy* is colorful and well done, but the program offers only introductory information about planets, comets, the greenhouse effect, and other aspects of the solar system.

System and Price: 64K IBM PC; $30

Manufacturer:
Cross Educational Software
1802 N. Trenton St.
P.O. Box 1536
Ruston, LA 71270
(318) 255-8921

Space Base and Halley Patrol

Spacebase displays the night sky, complete with 400 stars, nebulae, and other celestial objects. It is a rather nice sky display program at a reasonable price.

Halley Patrol provides an almanac and observing aid for seekers of the famous comet. For those who do not own an Atari, Urania sells a VHS, Beta, and 3/4" format video tape of the program in action for $27.95. The video may not rival MTV extravaganzas, but for the

10...9...8...7...

If this software piques your interest in the cosmos, you may want other astronomical outlets. Some of our recommendations are listed below.

Calling Young Astronauts

If the stars hold a particular attraction for you, you may want to join the Young Astronaut Program. Launched in October of 1984, it seeks to motivate young students to study the sciences and prepare them for space-related careers. Schools, businesses, and community organizations form local chapters, which receive study and other materials. If interested, contact the Young Astronaut Council, 1015 15th St. NW, Washington, DC 20005.

Astronomical Society

For those who want to become more involved in astronomy, we suggest you consider the Astronomical Society of the Pacific, an international scientific organization founded in 1889 to increase public awareness of astronomy. The address is 1290 24th Ave., San Francisco, CA 94122, (415) 661-8660.

This Is Major Tom To Ground Control . . .

Frankly, we are surprised to see so few space shuttle flight simulators on the market. So far, we have tracked down only two.

Space Shuttle, from Activision, offers you the opportunity to launch the shuttle, orbit, dock with a satellite, re-enter, and land. The graphics are good; the program is easy to understand and operate; and the mission is tough. *Space Shuttle*, for the Apple and Atari retails for $24.95, Commodore 64 and 128, $29.95.

Orbiter, from Spectrum Holobyte, is still in beta testing. We have not seen the IBM PC program, but expect good things from the folks who brought you *Gato* and *Art Studio*.

Activision
2350 Bayshore Frontage Rd.
Mountain View, CA 94043
(415) 960-0410

Spectrum Holobyte
1050 Walnut
Boulder, CO 80302
(303) 443-0191

classroom, it is one of the most visual and least expensive ways to track the comet.

System and Price: 48K Atari; $17.95 and $19.95
Manufacturer:
Urania Systems
Box 4890
Richmond, VA 23220
(804) 358-4715

StarCal II

This program lists stellar events on a month-by-month basis. *StarCal II* also displays a representation of the night sky on the screen for any time between 15,000 B.C. and 15,000 A.D. Overall, it is quite functional.

System and Price: 64K IBM PC; $39.95
Manufacturer:
Software City
P.O. Box 11082 Station H
Nepean, Ont., Canada K2H 7T8
(613) 225-1305

Starchart

Starchart finds and plots 1660 stars, nebulae, and other stellar objects in graphic or tabular form. It calculates coordinates and has a print option. It is a well done package with a steep price.

System and Price: 64K Apple II, IBM PC; $52.95
Manufacturer:
Visionary Software
P.O. Box 1063
Midland, MI 48641
(517) 835-9025

Star Finder

This program finds and displays 46 stars and 88 constellations. It includes an option to print out information and display.

System and Price: Apple II; $44.95
Manufacturer:
Earl Enterprises
440 Harrell Dr.
Spartenburg, SC 29302
(803) 579-1305

Star Search

This adventure game places you in command of a ship on an expedition to the Epsilon Eridani solar system to find the source of alien signals. You choose the crew and equipment and perform

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SPECIAL SECTION

scientific experiments in the alien solar system. *Star Search* is an admirable classroom experience.

System and Price: Apple II; $45
Manufacturer:
Earthware Computer Services
P.O. Box 30039
Eugene, OR 97403
(503) 344-3383

TellStar II

One of the more polished astronomy programs, *TellStar II* plots planets, stars, the moon, and deep space objects. It displays the starfield, draws lines between stars to form constellations, and sends text and graphics to a printer. A set of five utilities provides astronomical conversions and data on the Solar System. We recommend a serious look.

System and Price: 128K IBM PC, 512K Macintosh, 48K Apple II; $79.95
Manufacturer:
Spectrum Holobyte
1050 Walnut
Boulder, CO 80302
(303) 443-0191

The Halley Project

This is a game of solar system navigation. You must decipher clues, travel from Halley's Comet to a planet or moon, orbit, and land at secret bases on the various planets and moons. For example, on the second mission, you must land on a planet with no moons. The third mission requires you to land on a moon with an atmosphere. The documentation does not hold the answers—you must look them up in an outside reference source. You may learn a bit about the solar system, and you will definitely have some fun.

System and Price: C64, Apple II, Atari; $44.95
Manufacturer:
Mindscape
3444 Dundee Rd.
Northbrook, IL 60062
(312) 480-7667

The Observatory

This quality program features a map of the night sky with magnification of up to 512x to provide a front row seat from which to view eclipses, stars, and other astral occurrences. Star location, distance, magnitude, and other galactic

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information are readily available.

System and Price: 64K Apple II; $49.95

Manufacturer:
Lightspeed
2124 Kittredge, Suite 185
Berkeley, CA 94704
(415) 486-1165

The Sky

The Sky calculates the coordinates of planets, Messier Objects, sun, moon, and hundreds of stars. The 360-degree scroll is very nice, and the locate object feature is exceptional. You can even print the information. *The Sky* is definitely worthwhile for serious amateur astronomers. An 8087 coprocessor is recommended.

System and Price: 256K IBM; $60

Manufacturer:
Computer Assist Services
1122 13th St.
Golden, CO 80401
(303) 277-1014

The Visible Universe

Initially available for the Wang PC and translated to the IBM PC, this Basic program provides a view of the sky and 300 objects. It has the capability to print out information. An upgraded version with 10,000 objects is planned, to retail for $69.95.

System and Price: 256K Wang PC, IBM PC; $39.95

Manufacturer:
R.W. Parker
1949 Blair Loop Rd.
Danville, VA 24541
(804) 799-1008

Not Reviewed But Available:

Astro 64

This utility program calculates the location of the sun, moon, and planets.

System and Price: C64; $19.95

Manufacturer:
Michael C. Ciavola
6634 Montague St.
Philadelphia, PA 19135

Sinclair Series

A series of eight programs includes *Astro-Utilities, Relativity, Planets, Orbit, Galaxy, Print Planets, Comet*, and *Almanac Generator*.

System and Price: 16K Sinclair ZX81 and Timex Sinclair 1000; $9.95 and $11.95

Manufacturer:
Robert C. Moler
5999 Secor Rd.
Traverse City, MI 49684

Solartek

Primarily for solar heating system installers, *Sungraph* calculates and graphs the position of the sun.

System and Price: TRS-80 Model I, III, and 4, IBM PC, Apple II; $49

Manufacturer:
Solartek
RD #1 Box 255A
West Hurley, NY 12491 ■

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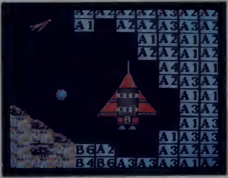

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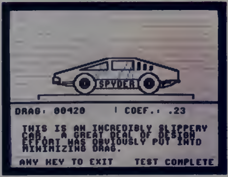

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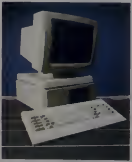
& Build

ITT Xtra XP

The power of an AT for the price of an XT/ **Joe Desposito**



Xtra XP

CPU: 80286
RAM: 512K
ROM: 64K
Operating System: MS-DOS 2.11
Disk Drives: 10Mb hard disk; 360K floppy
Dimensions/wt: 14" x 15.6" x 5.6"; 21.5 lbs.
Summary: A high performance system at a competitive price
Price: $4365
Manufacturer:
ITT
320 Park Ave.
New York, NY
10022
(212) 752-6000

CIRCLE **401** ON READER SERVICE CARD

To paraphrase the Wendy's commercial, "Where's the Xtra?" was a legitimate comment on ITT's first microcomputer. Not so the second time around. The ITT Xtra XP abounds with extra features that make it one of the most powerful machines on the market at a very competitive price.

Basically, what ITT has tried to accomplish is to design a PC with the performance of an IBM AT (i.e., very fast) at the price of an IBM XT. The machine we reviewed had 1.64Mb of RAM, a 20Mb hard disk, and a color monitor. The standard configuration, however, includes a 10Mb hard disk, 512K RAM, and a monochrome display at a suggested retail price of $4365.

What makes it so fast?

When you first start using the ITT XP, it is immediately evident that the machine is very, very fast. One reason is that it uses Intel's high performance 80286 microprocessor, which runs at 6MHz. But there are other reasons, too. A hardware reason is that it uses 512K of onboard, 16-bit, zero-wait-state DRAM (expandable on board to 640K). A software reason is something called FXP automatic I/O management.

FXP is a sophisticated enhancement to DOS 2.11. It both establishes a disk cache for the hard disk and provides a print buffer. Both the cache and buffer are alotted a dedicated area of system memory. FXP monitors the activity of the hard disk. When a program requests information from the disk, FXP checks the RAM cache first. If it is there, the information is passed directly to the program—no disk access is made. This significantly reduces the access time of the disk. Of course, if information is not in the cache, things slow down. An entire track containing the information is loaded into the cache, and the relevant data are then passed to the program. And since the XP does not use the AT's high performance drives, access time is about double that of the XT. But depending on the application, overall access time can be less than with an AT.

FXP also tries to correct some of the disk writing limitations of DOS. Even for small files, DOS moves the disk head many times to access a file. FXP, on the other hand, automatically starts writing modified tracks in the cache to the disk. It uses a technique called "elevator" writes to do this. This means that the track nearest the current position of the head is written first, followed by the next nearest, and so on, until all modified tracks are updated.

This elevator technique is analogous to what happens in a real elevator. Though people press numbers at random, the electronics of the elevator sort them out and deliver people to their floors in sequence. On the XP, this enables FXP to access files on the disk more quickly. Thus FXP increases disk access speed in two ways. It keeps frequently used files in RAM, and it writes all files back to disk in an optimum way.

The print buffer also increases system performance. Whenever you need to print a document, FXP sends the information from the program to an area of memory at high speed and then sends the information to the printer from this buffer area. In most cases, you don't have to wait for the printer to finish its work before you can resume using a particular program. But when a document exceeds the buffer size, you must wait until some of the information is printed.

More About the XP

The ITT Xtra XP system unit is fairly compact. At the front we find a 10- or 20Mb half-height hard disk drive and a 360K half-height floppy drive stacked one on top of the other. The keyboard connects to the

Apple Mac 512™

IBM PCAT™

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	ATARI™	IBM™ PCAT™	APPLE™ Macintosh™	COMMODORE™ AMIGA™
Price	$799	$4675	$2795	$1795
CPU Speed MHz	68000 8 0	80286 6 0	68000 783	68000 716
Standard RAM	5 2K	256K	512K	256K
Number of Keys	95	95	59	89
Mouse	Yes	No	Yes	Yes
Screen Resolution (Non-Interlaced Mode) Color Monochrome	 640 x 200 640 x 400	 640 x 200 720 x 350**	 None 512 x 342	 640 x 200*** 640 x 200***
Color Output	Yes	Optional	None	Yes
Number of Colors	512	16	None	4096
Disk Drive	3 5"	5 25"	3.5"	3.5"
Built-in Hard Disk (DMA) Port	Yes	Yes	No	No
MIDI Interface	Yes	No	No	No
No. of Sound Voices	3	1	4	4

**With optional monochrome board (non bit-mapped)
***Interlace Mode – 640 x 400

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The display we used was an ITT color monitor with a 14″ diagonal CRT. A non-glare etched surface and .31mm dot pitch give the monitor good readability in text mode. The monitor is mounted on a base that can be swiveled and tilted for easy viewing.

There are more software enhancements,too. VDISK gives you a way to create one or more RAM disks. And for users concerned about compatibility problems due to faster processor speed, the speed can be reduced to 4.77MHz by a CTRL-ALT-\ command.

Memory can be expanded beyond 640K with a proprietary expansion board from ITT. The board is available with 512K onboard and room for an additional 512K. The board can be used with FXP for cache and print buffering, with VDISK as a RAM disk, or via a software switch, as expansion memory for programs that take advantage of the Protected Virtual Address mode of the 80286.

A Keyboard with a Twist

The XP has an 84-key keyboard that is almost identical to that found on the IBM PC. However, there is one difference that touch typists will welcome. The lefthand SHIFT key has been interchanged with the backslash key. This is great for first-time users, but somewhat frustrating for those who have accustomed themselves to the IBM PC layout. The other change is that the RETURN key is horizontal instead of vertical, with the open single quote key removed to a position over the right half of the RETURN key. An improvement over the IBM keyboard is the inclusion of a small light emitting diode (LED) in the CAPS LOCK key.

Comments and Conclusions

We used the ITT Xtra XP for several weeks and were thoroughly impressed with its exceptional performance. A database application (*Pfs:File*) ran particularly fast on the XP. For example, an initial search of the database is performed at high speed due to the faster processor speed and the hard disk. If a desired record happens to reside in the cache, it appears instantaneously when requested. Then, if you need to print a record or group of records, you are returned almost immediately to the program as the print buffer does its job. What it all adds up to is much greater productivity.

There are also some drawbacks to the machine. The main one is with the disk drive. Some of the high performance drives for the IBM AT automatically park the hard disk heads when power is interrupted, which makes a disk crash unlikely. With the ITT, however, you must invoke a command called SPINDISK to park the heads. This means that a careless bump could spell disaster if you neglect to park the heads after using the machine.

Overall, I was really pleased with the performance of the XP. In some applications it even delivers the instantaneous response that users crave from a PC, and many prospective compatible buyers will find this machine an attractive alternative to the IBM AT. Although suggested retail price quotes can sometimes be deceiving, it appears that the ITT Xtra XP has lived up to its goal of providing AT performance at XT prices. ■

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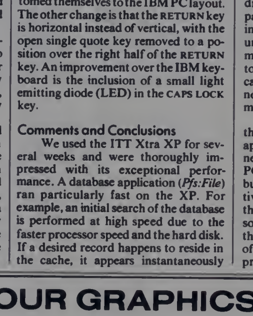

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SOFTWARE COMMENTARY

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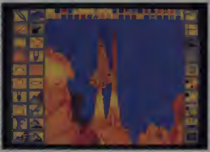
Art Studio



PERFORMANCE

EASE OF USE

DOCUMENTATION

UTILITY

OVERALL VALUE

System and Price: 128K IBM PC; $49.95

Summary: Well done graphics package

Manufacturer:
Spectrum Holobyte
1050 Walnut
Suite 325
Boulder, CO 80302
(303) 443-0191

CIRCLE **402** ON READER SERVICE CARD

Art Studio (and just about every other icon-driven graphics program for the IBM PC) owes quite a debt to *MacPaint*. Without a doubt, creating computer graphics (either business or personal) is far easier using a mouse than traditional methods. Why, the difference between P.M. (Pre-Mouse) graphics and A.M. (After Mouse) graphics is like the difference between night and day.

Art Studio is an effort to put color *MacPaint* on the IBM PC. The icons line the perimeter of the screen and represent all the familiar functions—boxes, continuous straight lines, cut and paste, fill, different fonts, spraypaint, and grids. You can select any of more than 40 patterns and choose from several different color palettes.

The bad news is the standard four-color graphics resolution of the IBM PC. In this medium resolution mode (320 x 200 pixels), the choice and combination of colors is limited. *Art Studio* helps you wring the most from these hardware restrictions, but do not expect the subtle differences in hue a CAD terminal package creates. Switching to high-resolution mode (640 x 200 pixels in two colors—black and white) improves the quality and definition of the graphics at the expense of color.

You might experience some difficulties in choosing a pattern icon using the keyboard. The cursor sometimes stops between the closely-packed icons. In addition, certain patterns tend to blur together. Only practice and experimentation will show you what works and what does not.

A few icons deserve mention: the arc, concentric circle and square, and radial line. The arc creates a quarter, half, or even a full circle, depending on the length of the arc. Concentric circle and square create the equivalent of rings on a archery target. Radial line is terrific for geometric patterns when several lines originate from one point.

One nice option, for those with experience with DOS and especially the DEBUG command, is the ability to capture screens from a Basic program, Lotus *1-2-3*, or other paint program and convert them to *Art Studio*. A similar process enables *Art Studio* files to load into other programs.

Spectrum Holobyte's *Art Studio*, like other drawing programs, requires quite a bit of practice before you can create space shuttle scenes and other artistic extravaganzas. Nevertheless, for those with the diligence and interest, it is a solid graphics package, and the $49.95 pricetag is bound to please. *—RSL*

Sidekick

PERFORMANCE

EASE OF USE

DOCUMENTATION

UTILITY

OVERALL VALUE

System and Price: 128K IBM PC, $54.95 (copy protected); $84.95 (unprotected)

Summary: Handy desktop organizer

Manufacturer:
Borland International
4585 Scotts Valley Dr.
Scotts Valley, CA
95066
(408) 438-8400

CIRCLE **403** ON READER SERVICE CARD

Like Tonto and The Lone Ranger, Robin and Batman, Pancho and The Cisco Kid, the newest version of the *Sidekick* desk organizer and your IBM PC form an inseparable pair. And faster than you can say "Kimosabe," "Holy Cow," or "Oh Cisco," *Sidekick* opens a window on the screen and places a notepad, calculator, Rolodex/modem dialer, calendar, or ASCII table before your eyes.

All windows can be moved around the screen, enlarged, and contracted. Multiple windows overlay each other, although you can alter the order at any time.

The notepad is a full-screen *WordStar*-like text editor that includes advanced features like search and replace, full block operations, and use of the IBM extended character set. In addition, you can cut and paste data from anywhere on the screen into the notepad and restore deleted lines. *Sidekick* defaults the notepad to about a 4K size, although files can be as large as 50K. If you often find yourself scrabbling around your desk for a pen and paper to jot down an idea while in the middle of something else, the notepad function may well be worth the price of the package.

The calculator works like a hand-held calculator. It performs the four basic math operations, recalls a number from memory, and includes binary and hexidecimal modes.

The Rolodex/modem dialer keeps track of names and phone numbers and allows you to search for a particular string of characters. If you have a Hayes 300, 1200, 1200B, or close compatible modem attached to your computer, *Sidekick* will automatically dial the number you choose.

The calendar allows you to mark appointments from 8:00 a.m. to 8:30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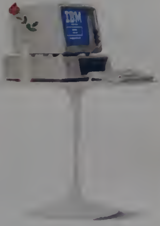

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processing ever? That's the whole point.

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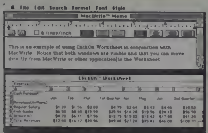
CIRCLE 141 ON READER SERVICE CARD

Little Tramp character licensed by Bubbles Inc s.a p.m. through the year 2099. This feature consists of two windows—the first to display an entire month, the second to display half a day of appointments.

The ASCII table command places the ASCII table in a window. Although of limited use to most people, programmers may find this helpful.

Sidekick certainly appears when you need it. At the press of a couple of keys, any or all of the functions pop onto the screen. If you like to do two (or more) things at once, *Sidekick* is compact, fast, easy-to-use, and handy, and could be your salvation. *—RSL*

ClickOn Worksheet



PERFORMANCE

EASE OF USE

DOCUMENTATION

UTILITY

OVERALL VALUE

System and Price: Macintosh; $79.95

Summary: An inexpensive way to integrate spreadsheet and graphics with any other programs

Manufacturer: T/Maker Graphics, 2115 Landings Dr., Mountain View, CA 94043, (415) 962-0195

CIRCLE **404** ON READER SERVICE CARD

If you are interested in integrated software, but are unwilling to pay hundreds of dollars for it, *ClickOn Worksheet* could be the product for you. This new offering from T/Maker Graphics is a spreadsheet and graphics program that resides under the apple on the Mac menu bar, which means it can be accessed like a desk accessory.

It is simple to install and use. For example, you can install the *ClickOn Worksheet* on a *MacWrite* disk by simply moving an icon over to the disk and opening it. Once installed, you can start the program from the accessories menu while you are running *MacWrite*. Thus, you have an integrated word processor, spreadsheet, and graphics program.

The spreadsheet is small but useful with 50 rows and 20 columns. Though it lacks some of the features of a full-blown product like *Multiplan*, it includes the functions that are used most often. One feature that might annoy users: calculations are not automatic and must always be invoked from either the menu or the keyboard. On the plus side, 12 popular worksheet overlays are included with the package.

The graphics feature lets you create pie, line, bar, and stacked bar charts from the information on the spreadsheet. You can also create titles and legends. Moving either a graph or data from the spreadsheet into a *MacWrite* document is done using Copy and Paste commands. Once a graph is moved to *MacWrite*, its size can be changed.

The biggest problem I had with the program was that it couldn't be easily installed on a Microsoft *Word* disk for lack of disk space. I essentially solved the problem by removing the System Folder, installing the *ClickOn Worksheet*, trashing the install program, and then replacing the System Folder. Hard disk users would not encounter this problem. Another problem may arise for 128K Mac users, who may run out of space while building a worksheet.

ClickOn Worksheet can be used with any program—not just a word processor. For example, if you use it in conjunction with *MacPaint*, you can customize any graphs created from the worksheet data.

At a price of $79.95, I think *ClickOn Worksheet* is well worth the money—even if you have a more powerful spreadsheet. The integration of word processing, spreadsheet, and graphics just can't be beat for saving time on those small jobs we all encounter from time to time. *—JD*

Wishbringer

PLAYABILITY

CHALLENGE

ADDICTIVENESS

EASE OF LEARNING

System and Price: Apple II, IBM PC, Atari ST, Amiga $39.95; C64, Atari $34.95

Summary: Engrossing interactive fiction

Manufacturer: Infocom, Inc., 125 Cambridge Park, Cambridge, MA 02140, (617) 492-6000

CIRCLE **405** ON READER SERVICE CARD

There is no harder task for a reviewer like myself than to comment on a work of interactive fiction. When I was assigned the task of assessing Infocom's new fantasy game, *Wishbringer*, I accepted only because it was touted as an introductory level game. I have had terrible experiences with higher level adventure-type games in the past.

Much to my dismay, *Wishbringer* started in normal fashion for me—I was stuck for about an hour in the first sequence of the game. If I went east, I couldn't get past a ferocious poodle; if I went west, I was eventually frustrated by a locked cemetery gate. But persistence, a small hint, and good documentation finally got me over the first hurdle, and I was on my way.

Now I have another problem. I can't get the game off my mind. I'm sure veteran players know what I mean, but it is a new sensation for me. It is very similar to solving a complex mathematical problem; if you get stuck, you leave it for a while and let your subconscious work on it.

So I found myself testing solutions that popped into my mind at odd hours of the day and night. Sometimes a solution worked, and it was very gratifying; other times, the frustration continued.

Infocom adds to the pleasure of the game by supplying real life props. In this case, the package contains a map of Festeron (later to be called Witchville), a special delivery letter to the proprietor of Ye Olde Magick Shoppe, and a glow-in-the-dark Wishbringer stone.

Wishbringer is no ordinary stone; it is a powerful, magical stone. When you hold Wishbringer, seven special wishes can be granted to help you overcome troublesome problems.

Though the game is a text-only fantasy, it does not suffer. The visual images conjured up in my mind have completely sufficed.

I recommend *Wishbringer* highly to the novice player, and I have a good idea that experienced players will find it engrossing, too. To make the game more challenging, advanced players may refrain from using the wishes, since "every problem ye encounter in thy travels may also be bested by the spell of Logick." But I have to go now, I just had an idea about how to spring the platypus from a pit too narrow for me to jump in.*—JD* ■

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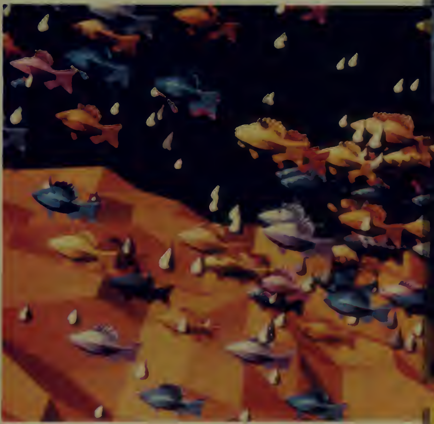
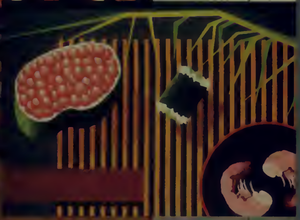
SIGGRAPH '85

The State of Art/**John J. Anderson**

Like the ascendancy of the abstract revolutionized art in this century, the ascendancy of the computer will surely revolutionize the next. Impressive evidence of this fact was lately gathered at Moscone Center, San Francisco, where over 30,000 people attended this year's SIGGraph Conference, bringing together the most talented computer artists in the world. The latest achievements in the field were presented, including a film show, prints, large scale sculptures, interactive installations, a display of computer graphics on frame buffers, and a well-scaled viewing environment for videotapes of experimental pieces. This year for the first time the art show provided visual documentation of the creative process as well. Here in pictures are glimpses of the most creative computing of 1985.





Opposite page, clockwise from top left: **Cloudscape, Geoffrey Y. Gardner**, On-line image, Grumman Research Center, Hardware: Data General Eclipse, Genisco GCT 3000, Matrix-2000; Software: G. Gardner. **New Vision, Steve Martino**, Cibachrome print, 16 x 20 in., Cranston/Csuri Productions, Inc., Hardware: VAX 11/780, Pyramid Technologies Mainframe, Marc III frame buffer; Software: Cranston/Csuri proprietary. **Homage à Bill Max, Martin Hefler**, Plotter print, 13.5 x 22 in., Hardware: Prime 250, Calcomp plotter; Software: Invisicalc. **Luminare, Dean Winkler and John Sanborn**, Videotape, Computer Graphics Center, VCA, Teletronics, Hardware: MCI/Quantel DPB7000 Grass Valley GVG-300, Ampex Digital Optics real-time image processors, Quantel DPE5000 + with frame store, Teletronics VI Square Communications control system; Software: Quantel VER.3.2, Ampex VER. 4.2, Quantel VER 4 with enhanced BBC teletrack Teletronics VI square Operating System VER. 12.3-R. Lund. **Home Again, Home Again (Higgeldy Jig), Lauretta Jones**, Cibachrome and linen card, 16.75 x 12.25 in., Hardware: Apple II +, Number Nine Board; Software: V-Point Plus.

This page, Above: **Microfishe, Vibeke Sorensen**, Color stereoscopic prints, 15.75 x 19.7 in., California Institute of Technology, Pasadena, Hardware: VAX 11/780, Raster Technologies frame buffer; Software: B. Vonherzen, D. Whelan. Right, top to bottom: **Daydreams, Mark Lindquist**, Digital Effects, Inc., Hardware: DEC 11/34, Lexidata frame buffer, Dicomed film recorder; Software: "C"-G. Miller; Collaborator: K. Sebek. **Sushi To Go, Martin Meguss**, Print, 16 x 20 in., Visual Images, Hardware: Genigraphics 100C; Software: System. **Portrait, Elaine Cohen**, Print, 11 x 14 in., Sheridon College Computer Graphics Lab, Ontario, Hardware: Dicomed D38; Software: System. **Cheri 2, Diana Desch**, Ink-jet print, 72 x 72 in., Hardware: IBM PC, Cubicamp frame buffer, Diablo C150 printer; Software: Time Arts-Easel by J. Schier.

SIMULATIONS:

PUT THE REAL WORLD IN YOUR COMPUTER

Simulations are models of one sort or another of real systems; they allow users to conduct trial-and-error experiments to predict behavior of the actual system over time or to allow a better understanding of the behavior of the real system (a system is simply an assembly of interacting components and processes). When we observe the output of the trail-and-error experiments of the simulation (or model) it is very much like observing the real system.

The simplest simulations to understand are actually *iconic models*—physical representations of actual objects. These models have some (but not all) of the characteristics of the systems they represent; they have the most essential characteristics. A model airplane is a good example of an iconic model; the model airplane may look very much like a scaled-down version of the actual airplane, but it usually lacks some of the operating parts of the real airplane (i.e., landing gear, control surfaces, communications equipment, etc.). The model airplane, however, even though it lacks many of the features of the real thing may be quite accurate in behaving like the real airplane in a wind tunnel. In fact, many wind tunnel tests of aircraft and airfoil design are not done on full-scale aircraft but rather on models.

For the aircraft designer the equations describing the aerodynamics of the airplane could be solved to predict the behavior of the aircraft under various conditions or, because those equations are probably difficult to formulate and solve, the scale model may be built and tested in the wind tunnel as an alternative. Wind tunnel tests of iconic models are *physical simulations*.

In some ways *computer simulation* is not much different from simulation using iconic models. We often use computer simulation when a mathematical solution to a problem is either impossible or difficult to formulate. The advantage to using a simulation from the point of view of the user is that the likely results of particular actions can be determined prior to actually trying the implementation. A simulation user can test several alternatives and choose the one that gives the best results; proposed solutions and policies can be compared in just a few minutes of computer time, while observation of real life results might take years to accomplish.

Iconic models, like the airplane model, are built because they are expected to behave like the real thing in most instances. Radio control modelers know that for the most part their aircraft behave with startling realism; often fooling passersby who believe they have seen actual aircraft. But radio control modelers also know that their aircraft have some peculiarities not found in their full-scale counterparts. Phugoid oscillation, the tendency of an aircraft to first zoom upward, stall, and descend rapidly over and over again, is much more pronounced in scale models than in actual aircraft. Modelers know this and adjust for it when flying their models; they realize the model is only an essential representation of reality, not a perfect representation. Likewise, computer simulations are only an essential representation of the reality they model.

The basics of simulation are incredibly simple, but actual applications, ranging from air traffic control to financial forecasting, can be quite complex. Computer simulations are mathematical models rather than iconic models like the model airplane; in these computer based *abstract simulations* sets of equations and mathematical relationships stand for the quantites and characteristics of the systems being modeled. The solutions to the equations form the output of the model and can be used to predict the behaviour of the real system. Most often, the output is simply in the form of text output or tables but some simulations (even microcomputer simulations) use graphic output as a better way of describing results.

Reasons for Using Simulation

When a system is not able to be studied directly it may be studied using simulation because:

- The necessary resources to observe the actual system may not be available (e.g., to build and test many prototype aircraft could be too expensive in practice).
- A precise mathematical solution may not be possible to develop, or it might take too long to develop.
- It might be impossible to observe the results on an actual system (a materials supply system for a continuously operating process, for instance, cannot be used to test different supply rates).
- There may not be enough time to "wait and see" results from an actual system; speeded-up results may require the analyst to "telescope" time (e.g., to wait for acid rain to possibly eliminate the giant redwood forests may be an ineffective way to study the effects of such fallout on the forest).

Difficulties with Simulation

There are also instances in which simulations as a problem solving technique or as a teaching tool are probably inappropriate:

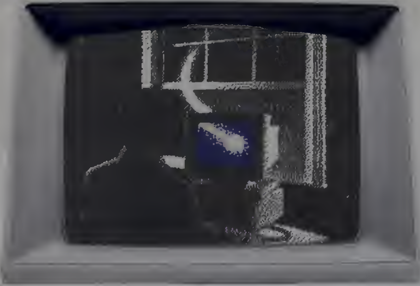
- Simulation does *not* yield exact answers. It deals with situations in which there is some uncertainty and so "answers" are approximations (in some cases, approximations that are not close enough to be useful).
- Creating a computer simulation of some situations may be quite expensive and out of date by completion.

Simulation Basics

All simulation models are abstractions of the systems which they represent, and to build a simulation the user must decide which characteristics of the real system are essential to the model and thus must be taken into account.

The two branches of simulation in common use on the microcomputer (and mainframes as well) are *discrete event simulation* and *continuous simulation*.

A discrete event simulation is a system constructed by defining the events where changes in the state of the system may occur. The model becomes dynamic by producing changes in the state of the system according to some time-ordered sequence. Queuing (waiting-in-line) problems are most often simulated as discrete event simulations: Suppose a bank has a single teller window; will the line at the window grow in length or



A swarm of killer bees, 500 years of acid rain, design of an SST, or even a salesman's schedule can best be studied with computer models/**Barry Keating**

hover about some particular length?

Continuous simulations describe the behavior of a system with a set of equations so that the system changes continuously with respect to time. The simulation may consist of algebraic, difference, or differential equations and in such a way is able to change continuously with time. An example of continuous simulation would be a model of an automobile front end suspension system in which the dynamics of running over various curbs, rocks, and potholes could be examined.

While discrete event simulations are characterized by large blocks of time during which nothing happens, continuous simulations assume that there is no instant in which nothing is changing (e.g., the suspension of the automobile is constantly changing as the tire rolls over new terrain).

Monte Carlo Simulations

Among the most frequently used kinds of discrete event simulations is the Monte Carlo simulations. The name dates back to World War II mathematicians John von Neumann and Stanislaw Ulam, who were trying to solve a problem at the Los Alamos Scientific Laboratory.

The problem they were working on was an extremely complicated one to answer and involved finding how far neutrons would travel through various materials. A trial and error solution would have been expensive and time consuming (there was a war on, and they needed the answers quickly). Their suggested solution was the equivalent of using a roulette wheel to determine step-by-step the probabilities of separate events and then merge them into a composite picture which gave them an approximate solution. At Los Alamos, von Neumann gave the secret work the code name "Monte Carlo," and this successful tool retains that name today.

Monte Carlo models have features that allow random events to be generated internally. In Basic, with the use of the RND (random) function, Monte Carlo simulations can easily be run on a microcomputer and are quite simple to construct.

```
50 T = 0:H = 0
100  PRINT "TOSS #","OUTCOME"
110  PRINT : PRINT
120  FOR I = 1 TO 10
130 X =  INT ( RND (1) * 2)
140  IF X = 0 THEN 170
150  PRINT I,"T"
155 T = T + 1
160  GOTO 180
170  PRINT I,"H"
175 H = H + 1
180  NEXT I
185  PRINT "T= ";T: PRINT
     "H= ";H: PRINT "PROBABIL
     ITY OF TAILS IS ";(T /
     (T + H))
190  END
```

Listing 1. Coin toss simulation.

TOSS #	OUTCOME
1	H
2	H
3	T
4	T
5	T
6	T
7	H
8	H
9	H
10	H

```
T= 4
H= 6
PROBABILITY OF TAILS IS .4
```

Figure 1. Coin toss sample output.

Consider the Applesoft Basic simulation of tossing a coin in Listing 1. Line 130 generates 0's and 1's randomly, and we arbitrarily assign the occurrence of 0 to a "head" and the occurrence of a 1 to a "tail." Figure 1 shows the output to a single run of the program simulating ten tosses of the coin; each subsequent run would produce results which could be different from the six heads and four tails in our trial run. As we simulate many tosses of the coin, the number of heads and tails would approach the 50% - 50% we would expect of a fair coin (change the number in line 120 to increase the number of tosses).

Of course we knew that a fair coin had exactly a 50% chance of giving a head on each toss, but what if we had not known the theoretical solution? That is where simulation can be of value; we could count up the results of thousands of actual coin tosses or we could simulate them in a few seconds on a microcomputer. The actual result in either case will rarely be exactly 50% heads and 50% tails, but the probabilities will tend to approach those "true" probabilities as the number of simulated tosses increases. We have then performed a Monte Carlo simulation using a powerful tool that can be applied to many business situations, logistics problems, scheduling studies, and system design situations.

Consider an actual situation in which simulation proved useful but in which the technique used was virtually identical to the coin toss situation. When the Dallas-Ft. Worth Airport was being constructed there was some question about how to construct the baggage handling facilities. Planners knew the approximate schedule of landings to be expected, the baggage capacity of the various aircraft, and other relevant pieces of information. They wished to build the luggage handling facilities in such a way as to minimize customer waiting at some reasonable cost.

A simulation model proved to be an ideal way to examine the effects of vari-

Top of the Line

The most sophisticated computer simulations today are done by commercial corporations like Link Simulations Systems Division of the Singer Company (yes, the same people who make the sewing machines). At their Silver Spring, MD, location they develop simulators for private corporations and for the U.S. government as well.

The U.S. Army hired Link to create a battlefield simulator called ARTBASS which would leave most computer game enthusiasts astonished with its capabilities. ARTBASS is a battalion level simulator for use in training battalion commanders in maneuver, fire support, and logistics. It offers a computer controlled scenario providing real time and interactive simulation of tactical operations. ARTBASS is definitely not a microcomputer simulation—it requires a multitasking processor of about the power of three Vax 11/780 minicomputers.

While the simulator is capable of running without graphics, it is the graphics that make ARTBASS so useful. The actual system is set up as five training stations (two maneuver control stations, one fire support station, one administration and logistics station, and one threat station) each of which includes CRT color displays. The screens depict in either two-dimensional or three-dimensional format the view of a potential battlefield from any map location. People training on the simulator, however, do not sit in front of the screens but are battalion commanders actually in the field in their command posts.

The company commanders see the screens and are in radio contact with the battalion commanders (just as in a real battle situation). The "combat math model" which drives the simulation can plot and move up to 200 separate units of 19 different types on 5000 square meters of terrain. Movement is in real time with updates every minute for land units and every 15 seconds for aircraft. The company commander may change his viewing position, and all will appear as if he were actually on location.

The "combat math model" calculates line-of-sight between all units, monitors visual detection adjusting for day/night and terrain features, and simulates fire as units detect one another. Air missions, degraded movement due to "hits" and casualties are all calculated in real time. The software is written in Fortran with only a few graphics routines in microcode for display speed. The scenario we viewed on a visit to Link was a Central Europe mockup, and it was like looking through a picture window. While the units themselves were represented by "counters" and looked unreal, the terrain was very realistic, showing contours and lighting effects for different times of the day and night.

ARTBASS Work Station.

ARTBASS display with 3-D shaded terrain and infantry unit markers.

Hope Creek power plant control room simulator.

Instructor work station for the Hope Creek simulator.

Link uses all off-the-shelf equipment to build the training stations. The entire training system (the army has purchased ten) is loaded onto two semitrailer trucks—one truck for the generators and processors and the other for storage of the actual workstations. The workstations are unloaded at the training site and connected by cable to the processor, which remains on its carrier.

Power Generation Systems

An older line of business for Link is power plant simulation; Link has been building simulators for the power industry since 1968. Both nuclear and fossil fuel plants have been replicated. The power plant simulators are typically mock-ups of the control rooms of these plants, complete with exact reproductions of the equipment used in the real control room—even the walls are painted with identical color schemes; plant noises and lighting effects are also reproduced in the simulators. As one Link engineer put it: "We are in the business of fooling people into believing they are where they are not."

The heart of these power plant simulators is again a minicomputer which remains behind the scenes running a mathematical model of everything in the plant from the reactor core (the most difficult part of any plant to simulate) to the large generators most plants contain. Since these replicas operate in real time, the realism is almost perfect (even boredom in watching for certain occurrences is present).

An instructor station, which looks like another computer terminal, allows the instructor to simulate virtually any plant condition: power demand, malfunctions, routine changes, and so on. A complete "history" of the happenings during any training session can be kept for review after the fact. Trainees can also retry circumstances with which they have had difficulty in previous sessions.

While the power plant simulators are built exclusively for training, there have been instances where the design of a plant has been changed because the simulator pointed out circumstances that the actual plant did not handle well. Innovative information displays used in some simulators are now being incorporated into actual control room panels.

Link Simulations Systems Division, 11800 Tech Rd., Silver Spring, MD 20904, (301) 622-4400.

ous luggage handling configurations on customer waiting time. With the model, planners could vary the arrival pattern of aircraft and see the results in passenger waiting time or they could vary the configuration of the aircraft landing (inserting many large aircraft one after another, for instance) and examine the likely waiting times. Clearly, this approach to planning facilities is superior to guessing at the results; of course, the results are only as good as the information fed into the simulation regarding aircraft arrivals, aircraft luggage capacity, occupancy rates, and so on.

An Example

Our example of simulation will be a discrete event simulation (a Monte Carlo simulation); we will examine bank customers arriving and being served by an automatic teller machine (ATM). Customers arrive at the ATM, wait for service if the machine is in use, are served, and then depart.

Customers arriving in the system when the ATM is in use wait in a single line in front of the machine. The arrival times of the customers and their service times are drawn from a probability distribution which we believe accurately describes the bank's customers. Our objective in running the simulation is to determine both how often a customer must wait longer than three minutes to be served and the average time a customer spends in line.

Because this simulation involves two instances of randomness in serial (first the customer's *arrival time* and second his *service time*) we call this a two-stage or multiple-phase simulation. The coin toss simulation was a single-stage simulation while the Dallas-Ft. Worth Airport simulation would obviously have been a many-phase simulation.

Our bank is unsure how many of its customers would use such a device and therefore how many of the ATMs to install. You, the manager, feel that customers would be quite annoyed at waiting longer than three minutes for service at the teller machine, and you suggest that a simulation of one teller machine might indicate whether the purchase of a second machine is necessary.

Gathering the Information. An analysis of the arrival pattern of 100 customers at an ATM at a branch of the downtown bank allowed the construction of the interarrival time frequency distribution in Table 1. Observations of 100 customers actually using the automated teller machines at the branch revealed the service time frequency distribution in Table 2.

When the Dallas-Ft. Worth Airport was being constructed there was some question about how to construct the baggage handling facilities.

The last column in each of these tables represents the set of assigned numbers (like the 0 for heads and 1 for tails) we will use to represent a particular category. For instance, in Table 1, 18% of the digits between 0 and 99 (i.e., the digits 0 through 17) were assigned to represent an arrival interval of 1 minute; 17% of the numbers (18 through 34) were assigned to represent an arrival interval of 2 minutes, and so on. When a particular random number is generated in our simulation, we will compare that number with the assigned numbers in column 4 to determine either when the customer is arriving (Table 1) or how long the customer uses the ATM (Table 2).

Running the Simulation. The form shown in Table 3 was constructed to allow the simulation to be run by hand. The form takes into account that the manager wants to look at both the arrival pattern of customers (which involves randomness) and the service time accounted for by each customer which also involves randomness).

To run the simulation, a set of random numbers between 0 and 99 is generated and placed in column 2 of Table 3; these numbers are used to determine the arrival pattern of the customers in the simulation. We have generated only ten numbers corresponding to ten different customers here but in actual practice a simulation run might include several thousand customers (many more than either of us would like to calculate by hand).

A second set of random numbers is generated and placed in column 4 of Table 3 to determine the service time for each of the ten customers. These random numbers cannot be the same numbers used to derive interval arrival times, if we believe arrival times and length of service to be independent.

By comparing the random numbers in column 2 to the assigned numbers in Table 3, we can generate the interval arrival times listed in column 3. The random numbers in column 4 are used in the like manner to generate service times.

Column 5 of Table 3 is arrived at by taking the random numbers in column 4 and comparing them to the assigned numbers (column 4) of Table 2. In this way service times for our simulated ten customers are generated independently of their arrival times.

The First Customer. Column 6 of Table 3 is the column in which we actually begin the simulation run. Assume that the simulation starts at time 0. Row 1 of column 3 tells us that the first customer arrives four minutes after the last customer, but since there was no previous customer, we will take this to mean

Time Between Customer Arrivals	Number of Occurrences	Probability Distribution	Assigned Numbers
1	18	.18	0-17
2	17	.17	18-34
3	15	.15	35-49
4	12	.12	50-61
5	10	.10	62-71
6	9	.09	72-80
7	8	.08	81-88
8	5	.05	89-93
9	2	.02	94-95
10	1	.01	96
11	1	.01	97
12	1	.01	98
13	1	.01	99
Total	100	1.00	

Table 1. Interarrival Time Frequency Distribution.

Service Time	Number of Occurrences	Probability Distribution	Assigned Numbers
1	48	.48	0-47
2	20	.20	48-67
3	16	.16	68-83
4	12	.12	84-95
5	2	.02	96-97
6	2	.02	98-99
Total	100	1.00	

Table 2. Service Time Frequency Distribution.

four minutes after the beginning of the simulation. The customer's arrival time will then be written in column 6 as 04 (or four minutes "into" the simulation).

Since there are no customers currently using the ATM, this first customer may be served immediately, so "time service begins" in column 7 is also 04.

By consulting "service time" in column 5 we see that this customer requires two minutes to be served, so that if service begins at 04 the customer is free to leave two minutes later at 06 (this is written in column 8).

Subsequent Customers. Row 2 of Table 3 represents the second simulated customer. Note that this customer arrives one minute after the previous customer (column 3) and so arrives at time 05 (column 6). Since customer #1 is still at the ATM (because customer #1 does not leave until 06) customer #2 must wait until #1 has departed. This means customer #2 must wait one minute (column 9). It is just such instances that we are attempting to observe through simulation. Note that in row 8 of Table 3, which represents the eighth customer, a bottleneck occurs when three long service times occur consecutively. The eighth customer winds up waiting four minutes.

From the simulation it appears that with one ATM there will be some waiting time for customers. Whether this waiting time, on the average, is acceptable to the bank depends on the bank's willingness to accept the seemingly small risk of a customer waiting longer than three minutes. In this abbreviated simulation only one of the ten customers waits longer than three minutes. Whether the bank accepts this 10% probability that a random customer will wait more than three minutes should be compared with the costs involved in buying a second ATM with a resulting drop in the probability of waiting longer than three minutes.

```
#    IN    S  OUT  TIS   WAIT  STATUS

1    4     4  8    4     0     OK
2    6     6  14   8     2     OK
3    7     2  16   9     7     OVER
4    13    2  18   5     3     OK
5    14    2  20   6     4     OVER
6    18    4  24   6     2     OK
7    25    1  26   1     0     OK
8    27    4  31   4     0     OK
9    31    1  32   1     0     OK
10   37    4  41   4     0     OK
11   39    2  43   4     2     OK
12   45    1  46   1     0     OK
13   49    3  52   3     0     OK
14   55    1  56   1     0     OK
15   58    3  61   3     0     OK
16   61    3  64   3     0     OK
17   62    3  67   5     2     OK
18   63    2  69   6     4     OVER
19   69    1  70   1     0     OK
20   70    3  73   3     0     OK
21   73    1  74   1     0     OK
22   75    3  78   3     0     OK
23   82    1  83   1     0     OK
24   83    2  85   2     0     OK
25   86    4  90   4     0     OK

THE NUMBER OF TIMES A CUSTOMER HAD TO
WAIT LONGER THAN THREE MINUTES
= 3 TIMES

MAXIMUM WAITING TIME WAS 7 MINUTES
AVERAGE WAITING TIME WAS .26 MINUTES
```

Figure 2. Program output of waiting times for twenty-five customer sample.

Accuracy. It is very dangerous to draw conclusions from truncated simulations. If we repeat the simulation many times, we can feel more confident of the accuracy of the results. We assumed that the variables in the simulation (arrival interval and service time) were independent of each other. If this is not true, then the simulation will provide poor results. Finally, we used discrete (as opposed to continuous) simulation. In actual practice continuously distributed variables might provide more accurate results.

Microcomputer Version

Almost any programming language can be used to write a simulation, but we will continue our extended example by using Applesoft Basic (see Listing 2). The subroutine at line 200 generates one random number for the arrival interval and a second (different) random number for the service time.

In lines 80 through 140, the first of these numbers is used to calculate the customer's arrival interval (J), and in lines 160 to 185 the second random number is used to assign the same customer's service time (K).

The customer's arrival time (IA) is calculated in line 195; waiting time (IWA) is calculated in line 200; leaving time (IO) is calculated in line 210; and the customer's time "in the system" is given in line 215.

Each customer is represented on one line of output like the program output in Figure 2 where 25 customers were run through the system and 3 customers waited longer than three minutes. Given only this evidence, we would conclude that the probability a customer would wait longer than three minutes would be:

$$\frac{3 \text{ occurrences}}{25 \text{ customers}} \times 100 = 12\%$$

However, since we would like accuracy approaching the real world probability, we would be better off increasing the number of customers shuttled through the bank by increasing the number 25 in line 60 to simulate a much

1. Customer Number	2. Random Number	3. Interarrival Time	4. Random Number	5. Service Time	6. Arrival Time	7. Time Service Began	8. Departure Time	9. Customer Waiting Time
1	57	4	50	2	04	04	06	0
2	03	1	89	4	05	06	10	1
3	95	9	31	1	14	14	15	0
4	38	3	70	3	17	17	20	0
5	62	5	08	1	22	22	23	0
6	80	6	54	2	28	28	30	0
7	11	1	90	4	29	30	34	1
8	17	1	75	3	30	34	37	4
9	78	6	00	1	36	37	38	1
10	34	2	44	1	38	38	39	0

Table 3. Simulation run. Average waiting time = 0.7 minutes Maximum waiting time = 4 minutes

larger group of customers.

By changing the number of customers from the 25 in line 60 to 1000, I found that 51 customers had to wait longer than three minutes with the longest wait being ten minutes. In addition, I found the average waiting time to be .708 minutes. Because 51 of the 1000 customers waited longer than three minutes, the simulation suggests that there is approximately a 5% chance that a customer will wait longer than three minutes:

$$\frac{51 \text{ occurrences}}{1000 \text{ customers}} \times 100 = 5.1\%$$

This result is quite different from the result obtained using only 25 customers and is characteristic of this type of simulation. Convergence on the "true" answer will occur as large runs of the simulation are attempted. Try several 1000-customer runs and you will quickly convince yourself that the true answer is closer to a 5% chance of a customer waiting longer than three minutes than to the 12% chance we estimated with a run of only 25 customers.

Simulation Languages and Tools

While simulations can be written in virtually any computer language, it is often easier to use one of the specialized languages or software packages currently available. For small, short simulations, Basic or Fortran can be used. The disadvantage to using these general purpose languages, however, is that simulations can be very complex, and it is quite easy inadvertently to adopt some bad assumptions.

Special purpose simulation languages, on the other hand, are specifically adapted to those situations that occur most often in modeling. They run faster and make the programming simpler, and the finished product is less likely to contain common errors. Using a special purpose simulation language can be like gaining years of experience quickly. *Simulations* from Actuarial Micro Software is one such package available both for the Apple II series and IBM computers.

Simulations is actually a combination of two separate packages: Monte Carlo Simulations and GASS. Monte Carlo Simulations is a general purpose simulator which incorporates statistical analysis as well as the ability to run a Monte Carlo type discrete simulation. The statistical analysis section allows the fitting of the proper statistical distribution to your raw data. That distribution

Listing 2. Simulation of waiting time for automated teller machine.

```
1  HOME
10 L = 0
20 A = 0
30 IA = 0
40 IO = 0
50 MAX =  - 1000
55  PRINT "#"; TAB( 6);"IN"; TAB( 12);"S"; TAB( 15);"OUT";
    TAB( 20);"TIS" ; TAB( 25);"WAIT"; TAB( 30);"STATUS"
56  PRINT : PRINT : PRINT
57  REM  LINE 58 SETS A WINDOW WITH THE LEGEND AT THE TOP OF
    THE SCREEN.  IF YOU ARE NOT USING AN APPLE, DELETE THE LINE.
58  POKE 34,2
60  FOR M = 1 TO 25
70  GOSUB 2000
75  REM  "IR" REFERS TO INTER-ARRIVAL TIME OF CUSTOMERS
80  IF IR >  = 0 THEN J = 1
85  IF IR >  = 18 THEN J = 2
90  IF IR >  = 35 THEN J = 3
95  IF IR >  = 50 THEN J = 4
100  IF IR >  = 62 THEN J = 5
105  IF IR >  = 72 THEN J = 6
110  IF IR >  = 81 THEN J = 7
115  IF IR >  = 89 THEN J = 8
120  IF IR >  = 94 THEN J = 9
125  IF IR = 96 THEN J = 10
130  IF IR = 97 THEN J = 11
135  IF IR = 98 THEN J = 12
140  IF IR = 99 THEN J = 13
150 D$ = "OK"
155  REM  "IS" REFERS TO SERVICE TIME FOR CUSTOMERS
160  IF IS >  = 0 THEN K = 1
165  IF IS >  = 48 THEN K = 2
170  IF IS >  = 68 THEN K = 3
175  IF IS >  = 84 THEN K = 4
180  IF IS >  = 96 THEN K = 5
185  IF IS >  = 98 THEN K = 6
195 IA = IA + J
200 IWA = IO - IA
205  IF IWA < 0 THEN IWA = 0
210 IO = IA + K + IWA
215 ITS = IO - IA
220  IF IWA > 3 THEN D$ = "OVER"
225  IF D$ = "OVER" THEN L = L + 1
230 A = A + IWA
235  IF IWA > MAX THEN MAX = IWA
240  PRINT M; TAB( 6);IA; TAB( 12);K; TAB( 15);IO; TAB( 20);
     ITS; TAB( 25);IWA; TAB( 30);D$
245  NEXT M
250 A = A / M
254  PRINT : PRINT
255  PRINT "THE NUMBER OF TIMES A CUSTOMER HAD TO
     WAIT LONGER THAN THREE MINUTES = ";L;" TIMES
257  PRINT
260  PRINT "MAXIMUM WAITING TIME WAS ";MAX;" MINUTES"
262  PRINT
265  PRINT "AVERAGE WAITING TIME WAS ";A;" MINUTES"
280  PRINT
290 D$ =  CHR$ (4)
300  PRINT
320  END
2000 IR =  INT (100 *  RND (1))
2010 IS =  INT (100 *  RND (2))
2020  RETURN
```

is then used to generate the random events in the simulation. A set of results for a simulation run are presented in Table 4. This report gives a description of the results of a simulation.

The graph in Figure 3 displays the results of fitting a negative binomial distribution to a set of raw data. While the manual and the programs in *Simulations* are easy to use, they lack the power to perform multiple-phase operations like the one in the bank simulation above. This severely restricts the type of problem that can be handled with the package. As a teaching tool, however, *Simulations* is the best on the market for demonstrating Monte Carlo type simulations.

EZQ from Acme Software Arts is a package available only for the Apple II series computers and is definitely for those with some simulation experience. It is not designed to handle Monte Carlo type simulations but rather is oriented to solving differential, difference, and algebraic equations.

Dynamic simulations can be handled easily by *EZQ*. The author of the program, Gerald Gottlieb, sent us several articles from medical journals which describe the use of *EZQ* to run simulations of muscles, neuromuscular stimulation, and energy absorption of football helmets. This package requires good grounding in differential equations but can be invaluable for those who have expertise in that area.

EZQ provides both tabular and graphic output for easy analysis of results. An example of the graphic output is shown in Figure 4.

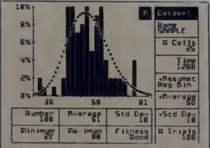


Figure 3. Monte Carlo Simulations matches a set of raw data to a particular probability distribution.

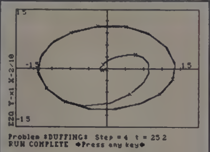


Figure 4. EZQ. Duffing's equation is a nonlinear differential equation which cannot be solved analytically but can be simulated.

```
DATASET PARAMETERS
------------------------------------------
        DATASET NUMBER:  2
          DATASET NAME:  SAMPLE
       NUMBER OF CELLS:  25
           TIME (HHMM):  1200
   DISTRIBUTION ASSUMPT:  3 Neg Bin
       ASSUMED AVERAGE:  50
  ASSUMED STANDARD DEV:  10
      NUMBER OF TRIALS:  100

OBSERVED RESULTS
------------------------------------------------------------------------
NUMBER OF ITEMS    =    100.00          GOODNESS OF FIT     = Good
   AVERAGE         =     50.80          DEGREES OF FREEDOM  =    10.00
STANDARD DEVIATION =     10.29          CHI-SQUARE VALUE    =    12.66
   MINIMUM         =     27.00          5% CHI-SQUARE VAL   =    18.31
   MAXIMUM         =     88.00          1/2% CHI-SQUARE     =    25.19
```

BEGINNING VALUE (CELL RANGE)	ENDING VALUE (CELL RANGE)	NUMBER (OBSERVED)	PROBABILITY (OBSERVED)	CUM PROB (OBSERVED)	AVERAGE VALUE (OBSERVED)	NUMBER (EXPECTED)	PROBABILITY (EXPECTED)	CUM PROB (EXPECTED)
ALL BELOW	23.32	0	0.00	0.00	0.00	0	0.11	0.11
23.33	25.66	0	0.00	0.00	0.00	0	0.16	0.27
25.67	27.99	2	2.00	2.00	27.00	1	0.58	0.85
28.00	30.32	1	1.00	3.00	29.00	1	0.81	1.66
30.33	32.66	0	0.00	3.00	0.00	1	1.34	3.00
32.67	34.99	1	1.00	4.00	33.00	3	3.43	6.43
35.00	37.32	0	0.00	4.00	0.00	3	3.48	9.91
37.33	39.66	2	2.00	6.00	38.50	5	4.56	14.47
39.67	41.99	10	10.00	16.00	40.60	6	5.64	20.11
42.00	44.32	13	13.00	29.00	42.77	10	10.22	30.33
44.33	46.66	7	7.00	36.00	45.43	8	7.67	38.00
46.67	48.99	8	8.00	44.00	47.75	8	8.00	46.00
49.00	51.32	14	14.00	58.00	49.86	12	11.90	57.90
51.33	53.66	5	5.00	63.00	52.60	7	7.43	65.33
53.67	55.99	9	9.00	72.00	54.67	7	6.76	72.09
56.00	58.32	11	11.00	83.00	57.45	9	8.59	80.68
58.33	60.66	4	4.00	87.00	59.50	5	4.62	85.30
60.67	62.99	2	2.00	89.00	61.50	4	3.76	89.06
63.00	65.32	2	2.00	91.00	63.50	4	4.19	93.25
65.33	67.66	2	2.00	93.00	67.00	2	1.98	95.23
67.67	69.99	2	2.00	95.00	68.00	1	1.47	96.70
70.00	72.32	0	0.00	95.00	0.00	1	1.47	98.17
72.33	74.66	4	4.00	99.00	73.50	1	0.63	98.80
74.67	76.99	0	0.00	99.00	0.00	1	0.59	99.39
77.00	79.32	0	0.00	99.00	0.00	0	0.23	99.62
79.33	81.66	0	0.00	99.00	0.00	0	0.15	99.77
81.67	ALL ABOVE	1	1.00	100.00	88.00	0	0.25	100.02
	TOTAL	100	100.00	100.00	50.80	100	100.00	100.00

Table 4. Monte Carlo Simulations results summary shows the data items along with the dataset parameters fitted by the program.

Slam II from Pritsker and Associates is a simulation language for the IBM PC which handles both discrete event *and* continuous simulation as well as any combination of the two. Mainframe simulation users will be familiar with *Slam*, the mainframe version of this language, which has been around since 1979. *Slam* is in wide use in industry for modeling production lines, transportation networks, communications networks, military operations, computer systems, and material handling configurations. Many universities also use the mainframe version as an instructional tool for neophytes to simulation; there are some fine teaching materials available for use with *Slam*.

The IBM PC version is relatively new and sure to catch the attention of old *Slam* users, because the commands are similar. The *Slam II* system starts by designing a network, or flow diagram, which graphically portrays the flow of entities (e.g., people, parts, information) through the system. The network is made up of nodes, and *Slam II* includes 20 different node types from which to choose. To analyze the model, the network is translated into a statement model which serves as an input file for *Slam II*. It is possible to write the statement form of the simulation directly, but most users will probably resort to the diagrammatic approach. *Slam II* for the IBM PC allows output to be written to DIF files so that users can manipulate output to create bar charts, pie charts, or plots with Lotus *1-2-3*, *VisiCalc*, or any other software recognizing the DIF format.

Micro-Dynamo is a simulation language, available for both the IBM and

Not Just for the Fun of It

Flight Simulator II

Space Shuttle.

Legionnaire

Simulations can be among the very best entertainment software on microcomputers. Most of the simulations tend to fall in one of two categories:

- *Mechanical simulations* in which some device or vehicle is simulated.
- *Historical simulations* in which some situation is simulated.

I have some personal favorites in each category to share with you. For mechanical simulations my choices are *Flight Simulator II, Gato,* and *Space Shuttle*. For historical simulations, among the best are *Fighter Command, Carrier Force*, and *Legionnaire*.

Each of my favorite mechanical simulations is a carefully researched recreation of an actual vehicle. *Flight Simulator II* from Sublogic mimics the characteristics of a Piper PA-28-181 Archer II, a single engine, 148 mph, fixed landing gear aircraft common in the U.S. today. *Flight Simulator* is by far the closest thing to actual flying on a microcomputer. It is a bit like a game, and yet it can be startlingly realistic.

My other favorite mechanical simulations are not quite as realistic as *Flight Simulator*, but they are true simulations in their own right. *Gato* from Spectrum Holobyte is a simulation of the most common type of fleet submarine in use during WW II.

In *Gato* you are confronted with a "mission" each time you boot up; the mission changes each session and is "displayed" to the commander through Morse code (it also prints out on the screen). Like an actual commander of a Gato class submarine, you have limited resources with which to complete the mission; your submarine is not an imaginary supervehicle of arcade quality but rather a limited vehicle with quickly realized limitations. After a few frustrating attacks on shipping you will quickly learn to think ahead and spend some time practicing maneuvers or forever remain committed to Davy Jones' locker.

Space Shuttle from Activision is your opportunity to replace Jake Garn and experience everything but g-forces. While *Space Shuttle* is less detailed as a simulation than either *Flight Simulator* or *Gato*, it is still great fun and a bit of an education for space flight neophytes.

Be forewarned that *Space Shuttle* is an attempt to model a flight of the shuttle in true simulation form and is not exactly the arcade game we would expect from Activision. Your mission is always to launch, rendezvous, and dock with a satellite as many times as possible while conserving fuel for the return to earth. Since I know virtually nothing about flying the real shuttle, I can't vouch for the realism, but I can say that the experience is enjoyable and even a little educational.

Now for the best historical simulations: there are so many good historical simulations, it is difficult to pick the best. By far the most popular with me is *Fighter Command*, the historical simulation of the Battle of Britain, which took place during WW II in August and September of 1940.

The simulation is as realistic as Strategic Simulations could possibly make it. You are placed in the position of Air Marshal for the RAF with all that he had at his disposal on any given day during the battle. The model simulates accurately the availability of different aircraft, the problems of logistics, the capability of the lately installed British radar, and the destructive force of various bombloads.

Another ideal situation for historical simulation purposes is the Midway campaign in the Pacific during WW II. *Carrier Force*, also from Strategic Simulations, accurately depicts that situation as well as the Coral Sea, Eastern Solomons, and Santa Cruz campaigns. In the Midway scenario you can choose the historical setup, which places ships and aircraft at their historical locations just prior to the battle; you can determine for yourself if the American victory was an historical fluke (as many have suggested) or if the odds were stacked in favor of the United States (almost nobody suggests this) by replaying the scenario a number of times using various strategies.

In both *Carrier Force* and *Fighter Command* you are confronted with a great deal of detail that must be absorbed and used. These commercial simulations are not designed for players who wish to boot up and start playing five minutes after opening the box. Skill in these games requires some learning and repeated practice.

A much less demanding (as well as a much less detailed) historical simulation is available in *Legionnaire* from Avalon Hill. This is really a quasi-historical simulation in that few details of particular battles are known with certainty.

Legionnaire is a real-time simulation of combat in the time of Caesar; you must make decisions as the battle is proceeding at a realistic pace. You control a varying number of Roman legions and some cavalry. Each unit has its own strengths and weaknesses, and you must keep these in mind as you issue orders to the unit commanders. The entire display is in graphic form, so the simulation is the easiest of those mentioned to play; it even includes the sound of marching legions. Your mission is to wipe out marauding armies of barbarians who are a threat to Rome.

Apple II series computers, that deals solely with dynamic simulations. The language will be familiar to some as the language used to model world resources by Jay Forrester in the World II Model. That simulation created quite a public debate because it illustrated the limits to economic growth imposed by natural resources and increasing pollution and overpopulation.

Figure 5 shows the "basic behavior" of Forrester's model as replicated in the Apple version of *Micro-Dynamo*. The model has fallen into some disrepute because of Forrester's generous assumptions, but that need not concern us here. In Figure 5, the NR curve is natural resources; the P curve is population; the QL curve is quality of life; and the POLR curve is pollution. Figure 5 presents the most powerful characteristic of *Micro-Dynamo*, its ability to display output with color graphics in easy-to-understand formats.

Dynamo is not a new simulation language; it dates back to 1958 and is in common use on mainframes. Those familiar with the mainframe version will see the similarity of the microcomputer version. The authors indicate that no special training in mathematics is necessary to use *Dynamo*, unlike the background required for *EZQ*. A knowledge of high school algebra is deemed sufficient for using the software. No knowledge of programming is necessary either, because *Dynamo* places the equations in proper order for processing.

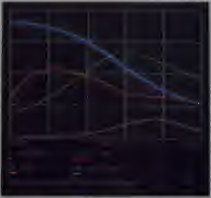


Figure 5. Jay Forrester's World II simulation uses Micro-Dynamo's color graphics.

Addison-Wesley Publishing, which produces *Micro-Dynamo*, also publishes a college textbook titled *Computer Simulation* which uses extensive examples, which can be programmed in *Dynamo*. The book is a good bet for those interested in dynamic simulations (note that the book does *not* treat Monte Carlo type simulations).

While most microcomputer users would not consider an integrated package to be a specialized simulation language, it is possible to perform Monte Carlo type simulations with some packages. A good choice for such a use would be *SuperCalc3* for the IBM PC or *SuperCalc3a* for the Apple IIe enhanced with 128K.

The *SuperCalc* software from Sorcim/IUS includes a random function similar to that found in Basic. This allows a user to set up a spreadsheet calling random numbers as any point to replicate any probability distribution. Since many microcomputer users are more at home with spreadsheets than with any of the programming languages, this could be a definite advantage in setting up simulations.

SuperCalc also has the ability to graph output from a spreadsheet, so graphic output from a simulation is relatively simple using the *SuperCalc* software. The *SuperCalc3* packages includes such a simulation as a demonstration template. Their demonstration is actually a blackjack game. A look at the formulas in the template will reveal the use of the random function to generate outcomes. The only bounds to using *SuperCalc* for simulation of discrete events is your own imagination. ■

PRODUCT AND MANUFACTURER INFORMATION

Carrier Force Apple II, C64, Atari $59.95 **Fighter Command** Apple II, C64, $59.95	Strategic Simulations, Inc. 883 Stierlin Rd., Bldg. A-200 Mountain View, CA 94043 (800) 227-1617 (800) 772-3545 (CA)
EZQ Apple II (3 versions) $79.95, $99.95, $199.95	Acme Software Arts P.O. Box 6126 Evanston, IL 60204 (312) 942-6412
Flight Simulator II Apple II, C64 disk, Atari $49.95; C64 cassette, $39.95	SubLogic Corporation 713 Edgebrook Dr. Champaign, IL 61820 (217) 359-8482 (800) 637-4983
Gato IBM PC, Apple II $39.95; Macintosh $49.95	Spectrum HoloByte, Inc. 2006 Broadway, Suite 301 Boulder, CO 80302 (800) 621-8385 (303) 443-0191
Legionnaire Atari, C64 cassettes $25; Atari, C64, Apple II disks $30	Avalon Hill Microcomputer Games 4517 Harford Rd. Baltimore, MD 21214 (301) 254-5300
Micro-Dynamo IBM PC, $395; Apple II (w/ Pascal 1.1) $245	Addison-Wesley Publishing Company Reading, MA 01867 (617) 944-3700
Simulations Apple II, IBM PC $395	Actuarial Micro Software 3915 A Valley Ct. Winston-Salem, NC 27106 (919) 765-5588
Slam II/PC IBM PC $975	Pritsker & Associates, Inc. P.O. Box 2413 West Lafayette, IN 47906 (800) 428-7636 (317) 463-5557
SuperCalc 3a Apple II $195 **SuperCalc 3 Release 2** IBM PC $395	Sorcim/IUS Micro Software 2195 Fortune Dr. San Jose, CA 95131 (408) 942-1727
Space Shuttle Apple II, Atari XE, XL $24.95; C64, C128 $29.95	Activision, Inc. P.O. Box 7287 Mountain View, CA 94039 (415) 960-0410

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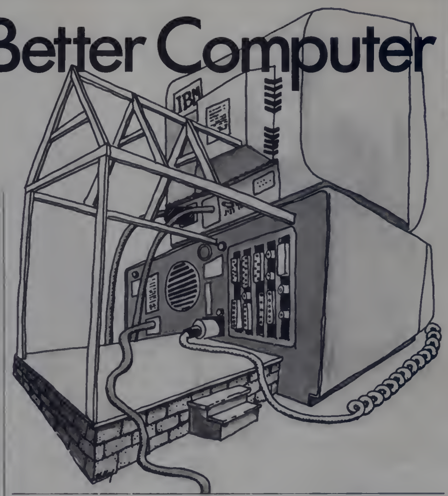


A look at some new, interesting, and affordable additions for your IBM PC

Russ Lockwood

We did a cover story last fall on upgrading your IBM PC. In particular, the expansion boards proved especially enticing—an easy and relatively inexpensive way to boost your computer power. IBM PC users have discovered what Apple II users have known for years—new expansion boards can infuse older hardware with new designs, applications, and productivity.

A horde of boards has been introduced for the IBM PC during the past year. We could easily fill several issues of the magazine with reviews of new boards, but space limitations restrict us to a selective approach.

In upcoming issues, we will follow through with 10,000 baud modems, 2Mb extended RAM boards, and other exciting developments. For now, we are taking a look at five innovative and inexpensive enhancements for the IBM PC.

Paradise Modular Graphics Card

Graphics boards have come a long way since IBM settled on a four-color resolution of 320 x 200 pixels as the standard for color graphics on the PC. Many of the new enhanced boards show 16 colors at the same resolution. The Paradise Modular Graphics Card displays both standard and enhanced graphics, drives a monochrome monitor, and displays true gray scale (in 16 shades) on a monochrome monitor. In effect, it functions like four graphics boards in one.

The board produces RGB or composite color graphics as well as graphics on an IBM or other monochrome monitor. Only one monitor at a time attaches to the board and a jumper (easily moved when the system unit cover is removed) matches the board to the type of monitor. The DIP switches on the IBM PC motherboard are always set to indicate a color graphics board.

Several DIP switches on the graphics board must be set to match the manufacturer and model for monochrome monitors. For example, the IBM monochrome monitor has a different switch setting from that of the Amdek 310A. Paradise includes a software program to calibrate and provide switch settings for monochrome monitors not already included.

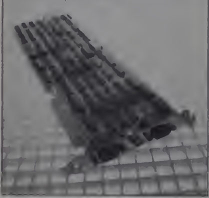
If you own an older IBM PC (circa 1982, before the ROM chip was changed), you may experience problems booting software using graphics on the IBM monochrome monitor. In our case, the monitor suffered from severe vertical roll, even after we used the Paradise-supplied calibration program and changed the switch settings. Paradise does provide a utility program to correct this deficiency, allowing us to run graphics programs from the A > prompt.

Paradise also includes a utility program to turn the screen flicker off. This marvelous little program benefits those who use a color monitor for text work.

The modular aspect of the Paradise Modular Graphics Card includes the ability to piggyback two modules to the main card. The $125 "A" module adds either an RS-232 serial port or a parallel port. The $195 "B" module adds a clock calendar and 64K (expandable to 256K) RAM. Paradise includes RAM disk, print spooler, and clock calendar software.

The Paradise Modular Graphics Card is easy to install, earns excellent marks for performance, and carries a competitive price of $395. It is best used with one-monitor set-ups, as removing the system unit cover to change the jumper from monochrome to color and back proves to be rather inconvenient. If you need a feature-packed graphics board, we recommend you take a look at the Paradise Modular Graphics Card.

STB Graphix Plus II



The STB Graphix Plus II is another second generation graphics board. It supports the standard RGB four-color IBM PC graphics at a resolution of 320 x 200 pixels as well as the enhanced 16-color graphics at the same resolution.

However, while the board displays true gray scale (16 shades) on composite monochrome monitors, it will not display such graphics on the IBM monochrome monitor unless the software comes with special drivers. STB includes the drivers only for Lotus *1-2-3*, Lotus *Symphony*, and Ashton-Tate's *Framework*. Without drivers, you can still run the IBM monochrome monitor for text and character graphics, but not true graphics. DIP switches on the graphics board determine whether color, monochrome, or both modes are used.

In theory, the board automatically switches between color and monochrome monitors depending on the software. In practice, the board works as advertised most of the time, but certain programs requiring graphics do not automatically switch to the color monitor. In these cases, you must use the DOS 2.0 MODE command to change monitors and run the program from the A > prompt.

The board comes with a built-in parallel port attached to the end of a ribbon cable. The port peeks out from the rear of the system unit.

The STB Graphix Plus II combines the color graphics adapter and the monochrome display adapter on one board and offers solid performance on both. It does not run graphics software on an IBM monochrome monitor without special software drivers, which are few and far between (STB manufactures the $395 Chauffer graphics board which runs graphics software on an IBM monochrome monitor).

At $395, the STB Graphix Plus II is competitively priced. For those with a two-monitor (text in monochrome, graphics in color) setup, we suggest you consider the Graphics Plus II. Those who are content with one monitor should look for another board.

Manzana MDP3 3.5" Disk Drive

If you own a Data General/One, Kaypro 2000, or other laptop computer with 3.5" floppy drives: just *how* do you transfer all those files created on 3.5" floppy disks to your IBM PC desktop computer with 5.25" floppy drives?

You could tangle with the RS-232 port, send the file via a modem, or lug around the optional 5.25" drives. However, a better solution is to plug the disk into the Manzana MDP3 drive.

This external unit connects to the disk drive controller board inside the IBM PC. A shielded signal cable runs from the 37-pin D connector on the back of the controller board to the rear of the MDP3 drive. An AC adapter provides power to the drive. You do not even have to remove the system unit cover to install the device.

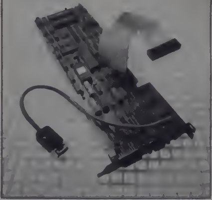
Two utility programs, a device driver and a format program, control the drive. The manual shows you how to set up an autoexec file to load the device driver automatically. The format utility operates much like the FORMAT command in regular MS-DOS. Several formatting options are available, including disk formats for single-sided drives, standard IBM 40-track schemes, and separate disk formats for the DG/1, TI Pro-Lite, HP 150, HP 110, and GridCase laptop computers. Note that the format for the DG/1 also works with a Kaypro 2000.

We tested file transfer and operation between an IBM PC and a Kaypro 2000. In a nutshell, the process was accomplished smoothly and without a hitch. In seconds, we exchanged several data and program files, all of which worked on the Kaypro 2000.

We think the trend toward 3.5" disks is gathering momentum—witness the Macintosh, Amiga, Atari ST, Apricot, and recently released laptop computers—and will eventually cause the 5.25" disks to go the way of 8" disks. Sooner or later, you might need a 3.5" drive for your IBM PC. Manzana, which is working on versions of the MDP3 for Compaq, AT&T, Leading Edge, IBM PC AT, and Tandy 1000 computers, offers a drive that is easy to install and even easier to use.

The $625 pricetag is a bit steep for a disk drive, especially when you can buy an add-on 5.25" disk drive and adapter for the Kaypro 2000 for about $450. On the other hand, the drive might save you enough time in transferring files to make it worth the price.

Trackstar



Do you remember Quadram's Quadlink? To jog your memory, the Quadlink (reviewed December 1983) is a plug-in expansion board for the IBM PC with 80K of RAM and a 6502 microprocessor. This Apple computer on a card allows you to run Apple software on your IBM.

In short, the Quadlink did the best it could, running Apple software that did not use half-track protection schemes, read parallel or serial ports, or check a specific area of Applesoft ROM.

Enter Diamond Computer Systems with an IBM PC expansion board called Trackstar. It includes a 6502 microprocessor for running Apple II+ software and a Z80A microprocessor for running CP/M software. The board works with the IBM PC disk drives, although it has a connector to hook up an Apple drive. Diamond aims for the educational market, where Trackstar allows schools to combine the resources of the vast library of Apple educational software with IBM PC business software.

We tried a variety of Apple programs using just the PC and PC drives. Almost all of the educational programs ran without a hitch. For games, the board worked about half the time. Diamond claims the board reads half-track protected software, although the company suggests using an Apple drive for "difficult programs." We tried a few business programs, and they also operated without difficulty, although programs written specifically for the IIe did not run. All IBM PC software ran without problems while the board was installed.

The pricetag of $499 is tempting, although you must decide if adding an Apple II+ and CP/M to an IBM PC is worth that much. We suggest strongly that you try the software you intend to use before buying the board. If the software runs and if you need to use a large library of Apple and CP/M software on an IBM PC, by all means take a look at Trackstar from Diamond Computer Systems.

Seattle Computer RAM 7

The RAM 7 is an expansion board with 256K RAM (expandable to 384K) and a clock calendar. Seattle Computer includes utility programs—RAM disk, print spooler, and diagnostics—with the board.

It installs quite easily: flick a few DIP switches and plug the board into an expansion slot. The RAM 7 board performs well, and we had absolutely no problem running software and setting up RAM disks.

Perhaps that is the highest accolade we can give this no-frills memory expansion board—it offers trouble-free installation and operation—except, of course, to point out the price of $195 for 256K RAM and $225 for 384K. ■

Firms Mentioned in this Article:

Paradise Systems
150 N. Hill Dr.
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(415) 468-6000

STB Systems
601 N. Glenville
Richardson, TX 75081 — CIRCLE 407 ON READER SERVICE CARD
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Manzana
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(805) 968-1387

Diamond Computer Systems
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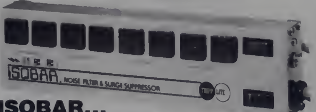

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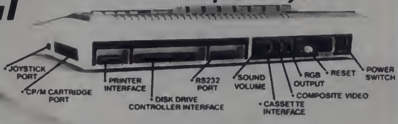

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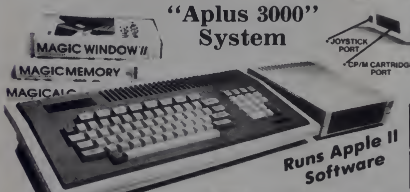

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CIRCLE 119 ON READER SERVICE CARD

PRINT ABOUT PRINTERS

Double duty printers/**Owen Linzmayer**

The theme of this month's column is Double Duty—which in this case refers not to Howdy Doody's twin brother but to printers that can perform more than one function. We look at the Brother Twinriter 5, which features a dual daisywheel and dot matrix printhead, and the Epson DX-20, a daisywheel printer that can function as a typewriter. But first, a few words about a book I would like to recommend to both prospective printer buyers and Epson printer users.

Although as a rule Epson user manuals are well written and exhaustive, infomaniacs may wish to pick up a copy of Addison-Wesley's *Epson, Epson, Read All About It!*. This 280-page tome authored by Julie Knott and Dave Prochnow is professionally done and contains informative reading on the entire line of Epson dot matrix printers (FX, MX, RX, and LQ-1500) and compatibles. Explaining print technology with practical programs and patches, this book retails for $14.95 and is a fine addition to any computer library.

Conversely, I recommend that you stear clear of Ballentine's *Epson Printer User's Handbook*. It offers little that isn't covered thoroughly in the Epson manuals that come packaged with the printers. Furthermore, the illustrations are childish and the text reads poorly.

Epson DX-20

BoldFace.

Underline.

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full feature
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Epson DX-20

Type: 96-character daisywheel
Feed: Friction (tractor, single sheet optional)
Speed: 20 cps **Interface:** Diablo APL
Summary: Inexpensive daisywheel with optional keyboard
Price: $459

Manufacturer: Epson America
2780 Lomita Blvd.
Torrance, CA 90505
(213) 539-9140

CIRCLE **411** ON READER SERVICE CARD

One of the highlights of a recent trip to California was visiting the Epson plant in Torrance, nestled between a corporate park and oil fields with pumping stations as far as the eye can see. Even so, the scenery was not as impressive as the new Epson DX-20 daisywheel printer that I had a chance to evaluate on the spot.

The Epson DX-20 is the wide-carriage big brother of the recently announced DX-10 with some significant improvements. Selling at $299, the DX-10 churns out characters at a rate of 10 per second and is healthy competition for the Juki 6000 that I reviewed on these pages last month. As its name implies, the Epson DX-20 is capable of reaching print speeds of 20 cps and retails for $459.

A peek under the hood reveals that the DX-20 accepts large Olivetti ribbons and can be fitted with any of 12 available 96-character printwheels. Also located under the front cover are the DIP switches which control certain printer defaults. Unlike many other manufacturers, Epson is thoughtful enough to label the functions of these switches. Character pitch (10, 12, and proportional), auto linefeed, page length, and sheet feeder options can all be set via this bank of switches as well as by software escape codes. The Epson DX-20 comes standard with a control panel featuring on-line, linefeed, and form feed switches in addition to power, ready, and paper out lamps.

When operating, the DX-20 sounds like those teletypes that drone mindlessly in the newsroom behind the evening anchorwoman. While it is just as loud as any other daisywheel printer, the DX-20 is unique in at least one respect: it can act as a typewriter with its optional keyboard module. Although several manufacturers offer typewriters that can function as printers, they often sacrifice quality and many desirable features. The DX-20, on the other hand, is a first rate printer and doubles as a fine typewriter for those tasks that are easier done manually than with a word processor.

The keyboard module plugs into the back of the DX-20, next to the Diablo APL interface. Its cable is six feet long and of the curled telephone handset variety. The full-sized keyboard is contained in a hard plastic case and can be propped up one half inch thanks to two support feet, an idea obviously borrowed from the IBM PC keyboard. Incidentally, the DX-20 keyboard boasts a caps lock light, something the IBM PC lacks.

All of the functions present on a standard typewriter can be found on the DX-20 keyboard including tab, margin, underline, pitch select, and shadow print. The "feel" of the keyboard is not on par with that of a Selectric, but it suffices, especially in light of the fact that the keyboard option is used only when a job is so small that it is most appropriately done without a computer. There is a slight delay between the time you strike a key and the time that the daisywheel prints that character. Although disconcerting at first, this effect is common on many electronic typewriters, and I did get used to it after a while.

The Epson DX-20 is a fine daisywheel printer in its own right, but the keyboard option merits additional praise. To be priced in the $100 range, the keyboard module obviates the need to buy both a typewriter and a computer printer. The DX-20 needn't be disconnected from the computer to function in its typewriter mode, just placed off-line, which means that it can be used as a typewriter by your secretary while you are busy preparing a report on the computer. I am very impressed with the Epson DX-20, and for that matter, the DX-10 as well. Both offer competitive features and exceptional value, in addition to reliability afforded them by their Epson heritage.

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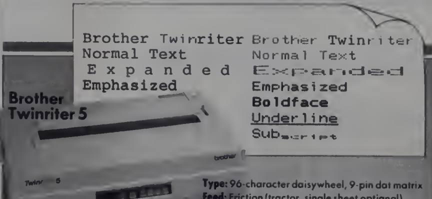

Brother Twinriter 5

Type: 96-character daisywheel, 9-pin dot matrix
Feed: Friction (tractor, single sheet optional)
Speed: 36 letter quality cps, 140 draft cps
Interface: Parallel **Price:** $1295
Summary: Dual printhead fills most printer needs
Manufacturer: Brother International
8 Corporate Pl.
Piscataway, NJ 08854
(201) 981-0300

CIRCLE **412** ON READER SERVICE CARD

Truly exciting developments in the printer industry are few and far between, but with the arrival of the Brother Twinriter 5 at our lab, we saw the industry reach another milestone. The Twinriter is the first printer to incorporate both daisywheel and dot matrix mechanisms in a single printhead.

Users have long been frustrated by the need for a daisywheel printer for word processing and a dot matrix unit for graphics and data processing. The Twinriter 5, with its unique dual printhead, solves this dilemma and saves time, space, and money as well.

The Twinriter 5 is a wide-carriage printer in an attractive off-white case that measures 23.2" x 7.9" x 15.0". The elaborate front control panel not only has the standard select, linefeed, and top of form buttons, it also comes complete with switches that allow you to configure the line and character pitch and the print mode. These buttons are accompanied by small lamps which indicate their status. The mode switch determines which print mechanism is to be employed and how it will behave. Although covered rather extensively in the 172-page user's manual, the print mode option is somewhat ambiguous.

Basically the Twinriter 5 operates in one of two modes: letter quality or draft. In the former, the daisywheel is used primarily, and the dot matrix printhead only comes into play to print special characters not in the daisywheel character set. The dot matrix printhead functions exclusively in draft mode. To confuse the issue further, the Twinriter also has WP (word processing) and DP (data processing) software command modes that act in combination with the letter quality and draft modes. If you are using software that was intended to drive a daisywheel printer, you should select WP. In the DP mode, programs that support graphics and require printing with the dot matrix can be used. Among these program types are spreadsheets, business graphs and charts, specialized graphics, and integrated software. Luckily, once you have selected your default settings, you needn't worry about what modes to use with your software.

As the sample printout demonstrates, the Twinriter 5 is capable of printing bold, shadow, sub/superscripts, auto underlined, emphasized, and expanded characters. In its native letter quality mode, the daisywheel can produce 36 cps, compared to the maximum of 17 near letter quality cps from the dot matrix printhead. Lest you be misled into thinking the Twinriter is slow, it should be made clear that the dot matrix printhead is capable of top speeds of 140 cps composed on a 7 x 9 matrix in draft mode. All in all, the Twinriter can hold its own against the competition, regardless of print mode.

However intriguing the dual printhead, the most astonishing aspect of the Twinriter 5 is that it costs only $1295, considerably less than two full-carriage printers. At this price, the Twinriter comes with a parallel interface, 3K buffer (expandable to 19K), and the option for a sheet- or tractor-feed mechanism. The Twinriter 5 can be used with virtually any computer system. Its versatility suits it ideally to office automation, yet its modest price makes it attractive for home businesses as well. Certainly the folks at Brother have proven once again that two heads are better than one. ■

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CIRCLE 125 ON READER SERVICE CARD

Programs that Understand Language

How they do it—syntax-directed methods/Part 2/ **William Wright**

Last month, in Part 1, we began to discuss programming methods for understanding or "parsing" artificial language. This month, we continue with an investigation of top-down vs. bottom-up parsers and conclude with a discussion of recursive subroutines.

Top-Down vs. Bottom-Up

The syntax of any valid sentence can be represented with a tree structure. "The boy ran down the road" can be diagrammed as in Figure 1.

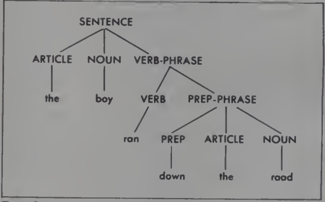
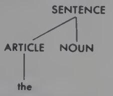


Figure 1.

The diagram is called a *derivation tree*. Each name on the tree is called a *node*. Each set of nodes is a *production* of the node from which it descends. In the diagram above, VERB PREP-PHRASE is a production of VERB-PHRASE. Obviously a language contains enough productions to build many different derivation trees (sentences), and it is unlikely that any particular derivation will contain all of the productions of a language.

The automatons that we discussed in Part 1 are called *top-down* because they deduce the top of a tree first and the bottom of a tree last. They don't output actual diagrams, but they "think" in a top-down fashion. Suppose that we were parsing "The boy ran down the road." A top-down machine would start at the top with SENTENCE.

We can think of SENTENCE as the first state of the machine. We hope that SENTENCE or one of the states that follows it will accept "the," at which time the machine will add nodes to the bottom of the tree:



We can think of ARTICLE as the state that accepted "the," and we can think of NOUN as the NEXT of the accepting state. We hope that NOUN or one of the states that follows it will accept "boy," and that the parse will continue in this fashion until the derivation is complete. Top-down parsing is called *predictive* because the NEXT of each state (each nonterminal node) predicts what should come next in the sentence. In the example, after the machine sees "the," it predicts NOUN and won't bother to check for ARTICLE or VERB.

Trees can be built from the bottom-up. In this case, machine begins at the bottom as in Figure 2.

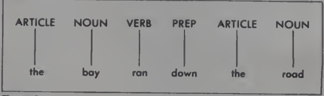


Figure 2.

The machine recognizes that PREP ARTICLE NOUN is a production of PREP-PHRASE, so it places a new node on top of the tree as in Figure 3.

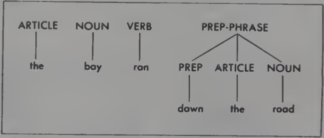


Figure 3.

The machine continues to build upwards this way until it reaches a single node at the top of the tree (SENTENCE). Bottom-up parsing is said to be *data driven* because it attempts to build a derivation with whatever words it finds, rather than expecting to find a particular class of word.

The top-down strategy is faster and simpler, but the bottom-up strategy has more power and reduces backup.

The primary shortcoming of top-down parsing has been mentioned already: the parser is stalemated if it can't make a prediction about the next word. Consider these sentences which are common in programming languages:

CMP VAR
CMP VAR,X

In the first sentence, VAR functions as a complete operand (analogous to a noun). In the second sentence, VAR modifies X (analogous to an adjective). Each of these sentences requires a different ACTION and NEXT for VAR, but the only way for the parser to choose is to peek ahead at the word that follows VAR. Will it be a comma or a carriage return?

In other words, the parser must use the bottom-up data-driven approach for a moment. Switching from top-down to bottom-up and back again is an accepted parsing technique when the application justifies the extra programming. Human beings probably read in this fashion. They expect certain standard constructions (top-down) and take a second look (bottom-up) only when their expectations aren't satisfied. Most artificial intelligence programs operate on this principle. When incoming data don't match the expectations of the program, the program looks for an alternate explanation that does fit.

Of course, a top-down parser can make an arbitrary choice without looking ahead, so long as it is prepared to back up if the choice proves incorrect. Sometimes backing up is unavoidable, but it is an expensive strategy. The automaton must save a copy of its variables whenever it faces an ambiguous word in case it needs to back up and test the other options. Another method of backup is to start a new set of variables (in addition to the original set) and to keep both sets up-to-date until a firm decision is possible. With this strategy, each ACTION must be prepared to start up and abandon extra variable sets also.

Backup becomes especially important when a language allows conversational variations. *Conversational* usually means that an error or ambiguity will be resolved by other words in the sentence. When the automaton finally reaches the words that resolve the problem, it will need to back up and do some reinterpretation.

Since bottom-up parsing checks the input against every word class in the language, rather than only those it expects, the bottom-up approach automatically distinguishes between spelling and syntax errors. A top-down parser can do this also, but only with extra effort.

Bottom-up Automatons

A bottom-up automaton consists of:

- A table of all the productions in the language.
- A model of the sentence.
- A loop that compares the model against the table.

The initial model is the sentence itself: The boy ran down the road.

The loop compares the model against the table and recognizes the following productions:

ARTICLE ———> the   NOUN ———> boy

VERB ———> ran   NOUN ———> road

PREP ———> down

So the loop rewrites the model by substituting:

ARTICLE NOUN VERB PREP ARTICLE NOUN

The loop compares the updated model against the table and finds another matching production:

PREP-PHRASE ——> PREP ARTICLE NOUN

So the loop substitutes again:

ARTICLE NOUN VERB PREP-PHRASE

This procedure continues until the model has been consolidated into the top node of the derivation (SENTENCE). Presumably, the loop will call the proper action subroutine each time it applies a production to the model.

Finite vs. Stack Machines

The model introduces a new mechanism: dynamic storage of information. The model is *dynamic* in the sense that its size and contents change in response to the needs of the moment. Automatons are called stack machines if they maintain dynamic information of any kind. Otherwise they are called finite machines. While it may be a misnomer, *finite* is intended to suggest static information that occupies a finite section of memory. *Stack* refers to the stack upon which dynamic information is stored.

For those who are unfamiliar with stacks, consider the analogy of a stack of plates. You can add or remove plates to or from the top of the stack whenever you wish. If you remove a plate, you get the one that was added most recently. Adding is called "pushing onto the stack" (suggests the spring-loaded stack of plates in a cafeteria), and removing is called "popping from the stack." In a computer, a region of memory is named "the stack," and a variable is initialized to point at the bottom boundary of the stack. Pushing is simulated by moving the pointer one location and then storing the datum where the pointer is pointing. Popping is the reverse operation. Thus, a stack is dynamic storage. It can be nearly full one moment and nearly empty the next.

Figure 4a illustrates how a bottom-up parser uses the stack to build and manipulate a model of "The boy ran down the road." The stack begins empty. The machine pushes nodes onto the stack for each of the words in the sentence and then consolidates the nodes into successively higher productions. Since the machine moves through the sentence from left to right, the rightmost node will always be on top of the stack. The stack pictures in Figure 4a are a movie of the progress of the machine up the derivation tree of the sentence. Most machines use small integers to represent the nodes. We will talk about Figure 4b in a moment.

Parsers can store other information on the stack besides a model of the sentence. We have hinted at the backup problem already. The parser must keep extra copies of its variables until an ambiguity has been resolved. A stack is the perfect storage depot for this dynamic information. As each ambiguity is resolved, the parser can "forget" about it by popping it off the stack.

The stack can be used to delay action subroutines when the meaning of a word is unclear (e.g., VAR in our earlier example). Whereas a finite machine calls each ACTION im-

Figure 4a. Stack movie during a bottom-up parse of "The boy ran down the road."

```
(EMPTY) —> ARTICLE —> NOUN    —> VERB    —> PREP    —>
           (EMPTY)    ARTICLE    NOUN       VERB
                      (EMPTY)    ARTICLE    NOUN
                                 (EMPTY)    ARTICLE
                                            (EMPTY)

—>ARTICLE —> NOUN    —>PREP-PHRASE —>VERB-PHRASE —>SENTENCE
  PREP       ARTICLE   VERB          NOUN          (EMPTY)
  VERB       PREP      NOUN          ARTICLE
  NOUN       VERB      ARTICLE       (EMPTY)
  ARTICLE    NOUN      (EMPTY)
  (EMPTY)    ARTICLE
             (EMPTY)
```

mediately after a certain word is recognized, a stack machine can keep a list of pending actions on the stack until the full meaning of an ambiguous word is known.

A parser needs a stack to handle recursive constructions like the parentheses in arithmetic expressions. No matter how many levels of parentheses have occurred in the sentence already, the expression can be enclosed in one more set of parentheses. Each new level forces the parser to suspend its current operation for a moment, so it needs a place to store information about the suspended levels until it has finished with the lower ones.

Finite machines live for the moment. They have no queueing ability. Stack machines can have queues, which adds another dimension to the expressive power of a language.

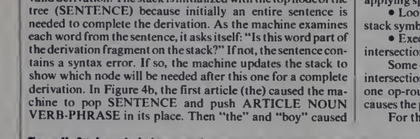
How Stack Machines Work

As Figure 4a illustrates, a bottom-up parser uses the stack to show what part of the derivation has been recognized already. Initially the stack is empty because no nodes have been recognized. As the machine examines each word from the sentence, it asks itself: "Can this word be added to the nodes already on the stack—as part of a production from the language?" If not, the sentence contains a syntax error. If so, the machine pushes the node of the word onto the stack. If this latest node happens to complete a production, the machine pops the entire production and pushes the appropriate higher node in its place.

In Figure 4a, the final NOUN (road) completed a PREP-PHRASE. Therefore the machine popped the entire phrase and pushed PREP-PHRASE in its place. Because PREP-PHRASE completed a VERB-PHRASE, the machine did another pop and push, and so on. The parse is complete when the machine has consolidated the contents of the stack into the top node of the tree (SENTENCE). Hopefully, the sentence will be exhausted at the same moment.

In top-down parsing, the procedure is reversed. Figure 4b shows a prototypical top-down parse of "The boy ran down the road." This time, the stack shows what is needed to complete a valid derivation. The stack is initialized with the top node of the tree (SENTENCE) because initially an entire sentence is needed to complete the derivation. As the machine examines each word from the sentence, it asks itself: "Is this word part of the derivation fragment on the stack?" If not, the sentence contains a syntax error. If so, the machine updates the stack to show which node will be needed after this one for a complete derivation. In Figure 4b, the first article (the) caused the machine to pop SENTENCE and push ARTICLE NOUN VERB-PHRASE in its place. Then "the" and "boy" caused the machine to pop ARTICLE and NOUN, leaving only VERB-PHRASE on the stack. "Ran" causes the machine to pop VERB-PHRASE and to push VERB PREP-PHRASE, and so on. The parse is complete when the stack is empty (when nothing else is needed to complete the derivation). Hopefully, the sentence will be exhausted at the same moment that the stack is emptied.

Figure 4b. Stack movie during a top-down parse of "The boy ran down the road."



A bottom-up machine is synthetic. It pushes a node for each word onto the stack and combines them into higher nodes until it achieves a single SENTENCE node. A top-down machine is analytic. It splits upper-level nodes into lower ones and then pops them off the stack as it matches them against words from the sentence. In both cases, the stack is available for other purposes such as pending actions, recursive productions, backup, etc. As we said earlier, the configurations through which the stack passes during a parse are a movie of the trip the machine makes up or down the derivation tree of the sentence.

To direct the continual updating of the stack, the machine has a control table. Each row in the table represents one of the stack symbols (nodes), and each column represents one of the input symbols (word classes). Each intersection of row and column contains the name of a subroutine that will perform the appropriate operation on the contents of the stack. A representation of the control table appears as Figure 5.

	Input Symbol (Word Class)		
Top	OP-1A	OP-2A	OP-3A
Stack	OP-1B	OP-2B	OP-3B
Symbol	OP-1C	OP-2C	OP-3C
	OP-1D	OP-2D	OP-3D
		. . . (etc) . . .	

Figure 5.

The parsing loop consists of:

- Identifying the input symbol for the current word (by applying spelling rules).
- Looking up the intersection of the input symbol with the stack symbol that is currently on top of the stack.
- Executing the op-routine whose name is stored at the intersection.

Some op-routines are error routines that represent illegal intersections of input symbol and top stack symbol. At least one op-routine must be a "parse-is-complete" routine that causes the parser to exit.

For the rest of this article, stack symbols will be capitalized and enclosed in brackets: [NOUN]. Input symbols will be in lowercase: [noun]. We will use a special stack symbol called [EMPTY] to indicate the bottom of the stack.

Top-down Stack Machine

Figure 6a is the control table for a top-down parse of "Tom saw the dog." Admittedly, this table will parse only a few simple sentences from natural English. Figure 6b is the stack movie. You should read each row of the movie this way: "WORD is an INPUT SYMBOL. The intersection of INPUT SYMBOL and TOP STACK SYMBOL is OP. After OP has been executed, the stack will contain STACK CONTENTS."

Applying this to the first row of the movie, we would read as follows: " 'Tom' is a [noun]. The

	[noun]	[verb]	[article]	[period]
[SENTENCE]	OP1	ERROR	OP2	ERROR
[NOUN-PHR]	OP3	ERROR	OP4	ERROR
[NOUN]	OP5	ERROR	ERROR	ERROR
[ARTICLE]	ERROR	ERROR	OP6	ERROR
[VERB]	ERROR	OP7	ERROR	ERROR
[EMPTY]	ERROR	ERROR	ERROR	EXIT

Figure 6a. Control table for top-down parse of "Tom saw the dog".

intersection of [noun] and [SENT] is OP1. After OP1 has been executed, the stack will contain [NOUN] [VERB] [NOUN-PHRASE] [EMPTY]."

The movie shows that both OP1 and OP5 are required to process "Tom." OP1 splits [SENTENCE] into a production beginning with [NOUN], and then OP5 pops [NOUN] off the stack. Stack machines often require more than one operation to process a single word.

Notice that the intersection of [EMPTY] and [period] causes the parser to exit. If [period] doesn't arrive exactly when the machine expects it, a syntax error will result.

Somehow the machine must generate calls to action subroutines. Each op-routine can call an ACTION itself, or the op-routine can bury an *action symbol* somewhere on the stack. When the action symbol rises to the top of the stack, the machine will call the corresponding action subroutine. By burying the action symbol, the op-routine can delay the action until more of the sentence has been processed.

The machine can store the translation of a word (or a pointer thereto) on the stack. This allows the translation to be altered several times before it is used. Compilers usually evaluate an arithmetic expression by burying the translation of the first word of the expression on the stack and then updating the translation as each subsequent word in the expression is processed. At some moment during the parse, the stack might look like this:

[ARITH-OPERATOR]
[VARIABLE-NAME]
[action symbol]
[translation]
[EMPTY]

As [ARITH-OPERATOR] and [VARIABLE-NAME] are recognized and popped off the stack, [translation] is updated. Now the stack will look like this:

[action symbol]
[updated translation]
[EMPTY]

Figure 6b. Stack movie of top-down parse of "Tom saw the dog."

Word	Input Symbol	Top Stack Symbol	OP	(←— Top of Stock) Stack Contents
				[SENTENCE] [EMPTY]
Tom	[noun]	[SENTENCE]	OP1	[NOUN] [VERB] [NOUN-PHR] [EMPTY]
Tom	[noun]	[NOUN]	OP5	[VERB] [NOUN-PHR] [EMPTY]
saw	[verb]	[VERB]	OP7	[NOUN-PHR] [EMPTY]
the	[article]	[NOUN-PHR]	OP4	[ARTICLE] [NOUN] [EMPTY]
the	[article]	[ARTICLE]	OP6	[NOUN] [EMPTY]
dog	[noun]	[NOUN]	OP5	[EMPTY]
"."	[period]	[EMPTY]	EXIT	

The machine calls [action symbol], which outputs [updated translation] and clears the stack of everything except [EMPTY]. Throughout all of this, the machine must not become confused by the various types of data on the stack (nodes, actions, translations, etc). Usually each routine knows exactly what to expect on the stack. In more complex cases, the machine might need a convention for data types, such as setting the high bit or odd vs. even.

Bottom-up Stack Machine

The control table and stack movie for a bottom-up parse of "Tom saw the dog." are shown in Figure 7. To simplify the illustration, some intersections in the control table have been left blank.

	[noun]	[verb]	[article]	[period]
[EMPTY]	OP1	-----	-----	ERROR
[NOUN]	----	OP3	-----	-----
[ARTICLE]	OP1	-----	ERROR	ERROR
[VERB]	----	ERROR	OP2	----
[NOUN-PHR]	----	-----	----	OP4
[SENTENCE]	ERROR	ERROR	ERROR	EXIT

Figure 7a. Control table for bottom-up parse of "Tom saw the dog."

OP1 is one of those op-routines that must search the stack for a complete production after it has pushed a node. In the case of "Tom," the stack contained only [NOUN] [EMPTY] after the push. Therefore, the search of OP1 for a complete production failed. In the case of "dog," the stack contained [NOUN] [ARTICLE] after the push, so OP1 popped them both and pushed [NOUN-PHRASE] in their place. This search-and-replace operation is the method by which a bottom-up stack machine consolidates lower nodes into higher nodes.

To streamline the search-and-replace operation, the machine can have alternate stack symbols for the same node. Each symbol will represent not only itself but also the symbol immediately below it on the stack. Suppose a language includes these productions:

[A] ——→ b c

[E] ——→ f c

The machine can have two alternate symbols for c, such as [C1] and [C2]. The machine will push [C1] if the stack already contains [B], but it will push [C2] if the stack already contains [F]. This way, the top stack symbol will always be an encoding of everything below it, and op-routines won't need to look any deeper to know which production (if any) to use. This method increases the size of the control table (several rows for the same node), but the machine executes faster.

The search-and-replace operation allows a bottom-up parser to postpone decisions. In the case of an ambiguous word (e.g., VAR in our earlier example), the machine can push an ambiguous symbol such as [OPERAND-OR-MODIFIER].

Word	Input Symbol	Top Stack Symbol	OP	(←— Top of Stack) Stock Contents
				[EMPTY]
Tam	[noun]	[EMPTY]	OP1	[NOUN] [EMPTY]
saw	[verb]	[NOUN]	OP3	[VERB] [NOUN] [EMPTY]
the	[orticle]	[VERB]	OP2	[ARTICLE] [VERB] [NOUN] [EMPTY]
dag	[noun]	[ARTICLE]	OP1	[NOUN-PHR] [VERB] [NOUN] [EMPTY]
"."	[period]	[NOUN-PHR]	OP4	[SENTENCE] [EMPTY]
"."	[period]	[SENTENCE]	EXIT	

Figure 7b. Stack movie of bottom-up parse of "Tom saw the dog."

Then the machine continues processing words until the stack contains enough information for the search-and-replace operation to select the correct production. The only limitation is that the machine can't push so many ambiguous symbols that the op-routines must become parsers themselves.

Bottom-up machines can use a similar technique to recover from syntax errors. Suppose the sentence was: "The light xyz shining." When the machine encounters the error (xyz), it pushes a special symbol, such as [UNKNOWN], and keeps going. Later, when the op-routine of [GERUND] attempts its search-and-replace operation, it will notice [UNKNOWN] on the stack. Rather than print an error message, it can ask:

DID YOU MEAN: The light "is" shining?

We have already discussed the disadvantages of backup during a parse. Most artifical languages are designed carefully to avoid backup. They are called *deterministic* because there is only one valid choice at each location in the sentence. Even if the language isn't totally deterministic, a bottom-up stack machine can avoid most backup by postponing decisions (pushing ambiguous nodes) and performing the search-and-replace operation when more information is available.

Recursive Machines

Another method of parsing uses subroutines that can call each other recursively. Each subroutine corresponds to the left side of a production. Suppose the language consists of four productions:

[SENT] ⟶ o[B]   [B] ⟶ o[SENT]

[SENT] ⟶ c   [B] ⟶ d

This language could be parsed by the program outlined in Figure 8a. Figure 8b shows the two recursive subroutines in the program, and Figure 8c shows the events in a parse of "a a c." The machine is recursive because each subroutine can call itself via the other subroutine. Recursive parsing is relatively easy to code and debug, but it consumes quite a bit of time and memory. It is a camouflaged stack machine because it needs a stack to store the RTS (return) linkages between the subroutines as they call each other. It is a top-down machine because each subroutine expects certain specific words to appear next in the sentence.

Formal Theorems

We have discussed parsing machines from an intuitive point of view. Languages can be categorized formally according to their production rules. Each category is parsed most effectively by a different configuration of tables and routines. If you are interested in a rigorous discussion, the following reference is more readable than most: *Compiler Design Theory*; Lewis, Rosenkrantz, Stearns; Addison-Wesley Publishing, 1976. ■

Figure 8a. Program for recursive parse of "a a c."

Initiolize WORD POINTER to the beginning of the sentence.

Coll SUBR-SENT

If WORD POINTER is ot end of sentence, the parse wos successful.

Else coll ERROR ond obort.

Figure 8b. Recursive subroutines for parse of "a a c."

SUBR-SENT: If the current word is "o," call the ACTION for o, odvonce WORD POINTER, call SUBR-B, ond return.

If the current word is "c," coll the ACTION for c, advonce WORD POINTER, and return.

Else coll ERROR ond obort.

SUBR-B: if the current word is "a," coll the ACTION for o, odvance WORD POINTER, coll SUBR-SENT, ond return.

If the current word is "d," coll the ACTION for d, odvonce WORD POINTER, and return.

Else coll ERROR and obort.

Figure 8c. Events during recursive parse of "a a c."

Porser colls SUBR-SENT

SUBR-SENT processes the first "o" ond colls SUBR-B

SUBR-B processes the second "o" ond colls SUBR-SENT

SUBR-SENT processes "c" ond returns

SUBR-B returns

SUBR-SENT returns

Parser verifies end of sentence

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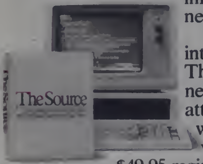

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WHAT'S NEW

The latest in hardware and software/**Russ Lockwood**

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Amstrad has introduced the CPC6128 microcomputer. It features 128K RAM, CP/M and AMSDOS operating systems, Basic and Logo languages, built-in 3" disk drive, *WordStar* word processor, and monochrome monitor for $699. Substituting an RGB color monitor for the monochrome monitor increases the price to $799. The Amsoft software publishing division of Amstrad has already published more than 100 programs in the 3" disk format.

Amstrad Computers
Merchandise Mart
Chicago, IL 60654
(312) 295-7100

CIRCLE **413** ON READER SERVICE CARD

Sublogic Graphics System

Sublogic, the folks who brought you the original *Flight Simulator*, has announced the High-Speed Graphics System for the IBM PC. Based around a custom graphics chip set designed specifically for graphics microprocessing,

the system displays up to 16 colors from a palette of 4096 at a resolution of 640 pixels x 400 pixels. It performs polygon fill at 400 million bits per second and draws up to 70,000 vectors per second. The System consists of two boards and retails for $2990. The custom chip set retails for $500.

Sublogic
713 Edgebrook Dr.
Champaign, IL 61820
(217) 359-8482

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More on LANs

Since our special section on local area networks in the October 1985 issue, Space Coast Systems has released SpaceWorks, a combination hard disk drive and streaming tape backup system available in 10Mb ($3295), 21Mb ($3995), and 42Mb ($4395) sizes, and SpaceServer, a disk server ($1995 plus $180 per connection) for up to eight stations on a local area network. Both products are compatible with the Apple II and III, IBM PC, and Apricot computers.

Space Coast Systems
301 S. Washington Ave.
Titusville, FL 32781
(305) 268-0872

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Complexx Systems has introduced the *Traverse Network Software System*, a set of utilities including electronic mail, file transfer, remote access, and terminal emulation for the IBM PC. The system operates over a variety of transmission media including modems, RS-232 cables, and the Complexx XLAN local area network. It costs $195 for a single user and $795 for a multi-user Unix V version.

Complexx Systems
4930 Research Dr.
Huntsville, AL 35805
(205) 830-4310

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Houston Instruments Graphics Tablets

Houston Instruments has announced the True Grid line of graphics tablets. Designed primarily for computer-aided design applications in architecture, surveying, and engineer-

ing, the tablets provide a high resolution of 0.01 inch and accuracy of +/- 0.01 inch, include choice of a light pen or mouse input device, and comes with an RS-232C compatible interface. Seven models range in size from 5" x 5" to 24" x 36" and are priced from $495 to $4340.

Houston Instruments
8500 Cameron Rd.
Austin, TX 78753
(800) 531-5205
(512) 835-0900

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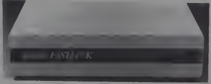
More Modem Magic

Since our May 1985 cover story on modems, several companies have introduced new modems.

Digital Communications has released Irma's Fastlink, a modem that transmits and receives data at speeds of



up to 10,000 bits per second. The product analyzes line quality and adjusts transmission speed, includes a self-checking feature, and uses a new data flow technique to respond to changes in the amount of data transferred between sender and receiver. Fastlink also transmits at 1200 and 300 baud, includes the Microstuf *Crosstalk-Fast* telecommunications program, and retails for $1995 (internal board) and $2395 (external unit).

Digital Communications
1000 Alderman Dr.
Alpharetta, GA 30201
(404) 442-4000

CIRCLE **418** ON READER SERVICE CARD

Tecmar has introduced the Phonegate 2400, a 2400/1200/300 baud internal modem for the IBM PC. It

features a Hayes-compatible command set, pulse and tone dialing, and off-hook detection. Tecmar bundles Respond, a telecommunications program, and Telephone Management, a directory program that also keeps track of calls, with the $789 Phonegate 2400.

Tecmar
6225 Cochran Rd.
Cleveland, OH 44139 CIRCLE **419** ON
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Quadram has announced the Quadmodem II, a 1200/300 baud internal modem for the IBM PC that can be upgraded to 2400 baud with a piggyback board. It features three auto call/answer modes, comes with *Crosstalk XVI* telecommunications software, and retails for $495. The piggyback board costs $300.

Quadram
4355 International Blvd.
Norcross, GA 30093 CIRCLE **420** ON
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Universal Data Systems has unveiled three modems: the 300 baud FasTalk desktop model for $345, the 1200 baud FasTalk desktop model for $525, and the 1200 baud FasTalk internal model for $525. The FasTalk line is Hayes-compatible, routes voice and other non-data signal during an online

connection to the modem speaker, and comes with SignOn telecommunications software.

Universal Data Systems
5000 Bradford Dr.
Huntsville, AL 35805 CIRCLE **421** ON
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Simon & Schuster Software

Simon & Schuster, well-known publisher of books, has released five programs.

Star Trek: The Kobayashi Alternative sends the crew of the Enterprise into a "Bermuda Triangle" in space to look for a lost ship. This $39.95 interactive text adventure holds a "personality database" for each of the well-known characters.

The Great International Paper Airplane Construction Kit, based on the book of the same name, offers arm-chair engineers the opportunity to design and fly paper airplanes electronically. The Macintosh version sells for $39.95; Apple II and IBM versions, for $34.95, and the Commodore 64 version, for $29.95.

Webster's New World Word Processor for the IBM PC and Apple II includes a spelling checker and thesaurus for $124.95. *Webster's New World Electronic Thesaurus* for the IBM PC holds 100,000 synonyms and retails for $59.95.

Lovejoy's Preparation for the GMAT for the IBM PC and Apple II presents 20 separate practice modules and over 150 pages of tips and techniques for taking the test. It retails for $79.95.

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1230 Avenue of the Americas
New York, NY 10020 CIRCLE **422** ON
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Managing Your Money Link to Fast-Tax

MECA, the publisher of the *Managing Your Money* (see full review in August 1985 issue) personal finance program, has announced *Fast-Tax 1040 Bridge*. The utility program, which reads the data disks of *Managing Your Money*, allows accountants and other financial advisors to send data disks directly to Computer Language Research, an income tax preparation service, and cut tax preparation time by up to 70%. *Fast-Tax 1040 Bridge* is included in *Managing Your Money* version 2.0. Depending on the warranty plan, owners of version 1.0 will receive the upgrade free of charge, for $39.95, or for $49.95.

MECA
285 Riverside Ave.
Westport, CT 06880 CIRCLE **423** ON
(203) 222-1000 READER SERVICE CARD

Memory-Resident Outline Processor

Living Videotext has released *Ready!*, an outline processor and desktop organizer for the IBM PC. It resides in memory and can be called up while other application programs like word processors, spreadsheets, and databases are running. The program allows users to define their own structures, including a notepad, Rolodex, and calendar. *Ready!* retails for $99.

Living Videotext
2432 Charleston Rd.
Mountain View, CA 94043 CIRCLE **424** ON
(415) 964-6300 READER SERVICE CARD

Source 2400 Baud

The Source Telecomputing has started 2400 baud service via Uninet and Tymnet. Initially available for 10 major cities, additional cities will be converted as soon as possible. Prime time access (weekdays 7:00 a.m. to 6:00 p.m.) costs $0.46 per minute, $0.03 more than 1200 baud service, and non-prime time (all other times) costs $0.20 per minute, $0.02 more than 1200 baud service.

Source Telecomputing
1616 Anderson Rd.
McLean, VA 22102 CIRCLE **425** ON
(703) 734-7500 READER SERVICE CARD

Enhanced PC Paint

Mouse Systems has released *PC Paint* version 1.5, a mouse-driven, 4- or 16-color graphics package for the IBM PC. It features automatic fill and shift functions, supports any mouse with a Microsoft-compatible driver, works in 16 colors with the STB Graphix Plus II board, and offers 44 on-screen patterns. *PC Paint* retails for $99; with optional mouse, $220.

Mouse Systems
2336 H Walsh Ave.
Santa Clara, CA 95051 CIRCLE **426** ON
(408) 988-0211 READER SERVICE CARD

VP Planner

Adam Osborne's Paperback Software has released *VP Planner*, a spreadsheet and relational database program for the IBM PC. It is compatible with Lotus *1-2-3*, *dBase II*, and *dBase III* and retails for $99.

Paperback Software
2612 Eighth St.
Berkeley, CA 94710 CIRCLE **427** ON
(415) 644-2116 READER SERVICE CARD

APPLE CART

Changing times; Managing Your Money; creating quilts; a new Nibble Notch; and new AppleWorks products / **Joe Desposito**

Years ago I worked with a guy who made an investment in a harness horse. The horse developed into one of the top pacers on the New York circuit and launched my pal into a career as a standardbred owner. Recently, he came to me with a problem.

He wanted to keep track of the performance of each of the 25 horses he now owns. He is using *Multiplan* on an Apple IIe and is having trouble with an apparently simple problem. All he wants to do is combine a horse's finish time with the track variant for the night. (A track variant is an indication in fifths of a second of how fast or slow the track surface is on a particular night.)

A problem arises when you enter times like 2:02.1 (read as two minutes, two and one-fifth seconds) into a *Multiplan* worksheet. The program doesn't know how to handle a number entered in this format. Additionally, the track variant is given as an integer value. For example, + 11 would mean that the track surface was 11/5 faster than normal. In this case, the desired performance factor would be 2:02.1 plus 11.

Naturally, when you input a number like 2:02.1 into a worksheet, it is treated as text rather than a number (the colon is a dead giveaway). So the first problem is transforming the text into a number. This can be done with the VALUE function. The next hurdle is caused by the intrinsic nature of time itself. As a number, time does not run in the same pack as ordinary decimal numbers. So a transformation is needed. This can be accomplished with the MID function.

As an example we'll transform 2:02.1 into its decimal equivalent, which is 122.2. First we'll use the MID function, which allows you to choose one or more characters of a text expression. The function has three arguments: text, start position, and number of characters. We can select the first 2 in the expression by using MID("2:02.1",1,1). Next we select seconds by using MID("2:02.1",3,2). Finally, we select fifths of a second by using MID("2:02.1",6,1). Using the MID function, we have isolated the numbers we want. But remember, the program still thinks that these characters are text!

To change each character to a number we need the VALUE function. So we use the two functions in combination as follows: VALUE(MID("2:02.1",1,1)), which returns the number 2. To finish off the formula we need the time-to-decimal transformation, which means multiply minutes by 60, divide fifths by 5 and add. In this case we have the following formula:

```
60 * VALUE(MID("2:02.1",1,1))
 + VALUE(MID("2:02.1",3,2))
 + VALUE(MID("2:02.1",6,1))/5
```

The performance factor is calculated by adding the track variant divided by five to the expression shown above. Once time is transformed into its decimal equivalent, it is much easier to graph and perform statistical calculations on a group of times.

> **At least one company thinks that Apple II users have an interest in sophisticated software.**

The only remaining problem is one of flexibility, and this is easily solved. Naturally, you wouldn't want to create a formula that had a specific time associated with it. Instead, you would include a cell reference. Thus you might have something that looks like MID R2C3,6,1) where R2C3 is a relative cell reference.

In closing, it is appropriate to note that this method can be used on any version of *Multiplan*.

Managing Your Money

Though much Apple II software has been ported to the IBM PC, it is rare to see a blockbuster IBM PC product revised for the Apple. For example, I don't think you'll ever see Lotus *1-2-3* or *Framework* running on an Apple IIc. But at least one company thinks that Apple II users have an interest in sophisticated software. That company is MECA, developer of Andrew Tobias's *Managing Your Money.*

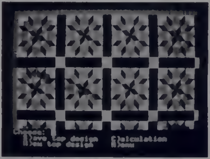
According to John Hawkins, executive vice president of MECA, the Apple IIc version will have all the features of the IBM PC version 1.52 of *MYM*. If you are not familiar with the program, take a look at what Ken Uston had to say about it in our August, 1985 issue. I think the program (on the IBM PC) deserves all the accolades it has been receiving.

Though *MYM* retails for $199, it has been significantly discounted at some outlets. The Apple version will run only on the IIc or an enhanced IIe with 128K. And Macintosh users have something to look forward to also. Hawkins says that a Mac *MYM* product is in the works.

Quite a Quilt

If you have ever created a quilt (or watched someone else do it), you can appreciate the amount of work involved. Now a new program from Random House, called *Patchworks*, can take at least some of the drudgery out of quilt making.

There are two parts to the program. One helps you design the quilt, and the other calculates the material needed for your design. I tried the program and found it exceptionally easy to create elaborate designs.



Patchworks

Because of the limitations of the Apple II as regards color, the program uses a unique way of creating color prints. When you create your designs, the program always uses the same three colors. If you have a color printer and want to print out your design, you can change the original colors.

The program was created by Dorothy and George Zoph. Dorothy has quilted for 36 years and has garnered some awards for her talent; her husband wrote the program.

The program is helpful in other areas of design, too. For example, you could use it to create a floor or wall pattern. However, you could not get automatic calculations for materials for these designs. Suggested retail price of *Patchworks* is $59.95.

Nibble Notch II

I suppose there are plenty of people who wonder why you can't use the flip side of your Apple II diskettes. Well, in fact, you can. *Nibble Notch* has been helping people do it for years with their disk notcher product. They also offer a disk called the *Disk Optimizer* that will

Nibble Notch Disk Optimizer II

verify the integrity of the media on the flip side. Their new product is the *Disk Optimizer II*, which works with ProDOS and Pascal as well as the older DOS 3.3. It also offers many user refinements, expanded documentation, and on-screen prompts. Purchased alone, *Disk Optimizer II* retails for $24.95. When purchased with the disk notcher, the cost is $29.95.

New AppleWorks Products

The popularity of *AppleWorks* has not been overlooked by third-party software vendors. Here are a few of the new products that enhance the capabilities of *AppleWorks*.

PBI software has released a new version of *GraphWorks*, the business graphics program for *AppleWorks*. *GraphWorks 1.2C* uses menus and folders similar to *AppleWorks* and includes a new tutorial on the program disk. The program allows you to store and recall graphs and has increased compatiblity with interface cards and printers. PBI has also removed copy protection from the new version, which sells for $79.95.

Another product from PBI is *Jeeves*, a desktop accessory for *AppleWorks*. It runs in the background and can be called with a single keystroke. There are five desk organizers: an appointment calendar, a four-function calculator, a memo pad, a phone dialer with directory, and a software alarm clock. *Jeeves* sells for $49.95.

Spellworks is a spelling checker for *AppleWorks* from Advanced Logic Systems. It contains 90,000 words and checks 10 words per second, yet sells for just $49.95.

And just so Apple II Plus users don't feel left out in the cold, Videx has developed the *AppleWorks Modifier*, a product that reconfigures the *AppleWorks* startup disk so the program can be used on the Apple II Plus with a Videoterm or Ultraterm card (80 columns) and the one-wire shift modification. The program requires a 64K Apple II Plus and provides 10K of editing memory. For more editing memory, the *AppleWorks Modifier* supports RAM cards (up to an additional 128K) from Titan Technologies, Abacus, and Legend Industries. Suggested retail price of the *AppleWorks Modifier* is $59. ■

Firms Mentioned in this Column

MECA
285 Riverside Ave.
Westport, CT 06880
(203) 222-1000

Random House
201 East 50th St.
New York, NY 10022
(212) 751-2600

Nibble Notch
4211 NW 75th Ter.
Lauderhill, FL 33319
(800) 642-2536

PBI Software, Inc.
1155B-H Chess Dr.
Foster City, CA 94404
(415) 349-8765

Advanced Logic Systems, Inc.
1195 E. Arques Ave.
Sunnyvale, CA 94086
(408) 730-0307

Videx, Inc.
Corvallis, OR 97330
(503) 758-0521

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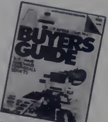

A+ BUYERS GUIDE is the most comprehensive directory of products and services for the Apple II, II+, IIc, IIe, III, Lisa and Macintosh on the market today! You'll find over 3,500 complete listings covering software, hardware, peripherals and services available for Apples and compatibles with essential information you need to evaluate what each product does and what you need to use it!

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FROM THE PUBLISHERS OF A+, THE INDEPENDENT GUIDE FOR APPLE COMPUTING

IBM IMAGES

Trade shows and other mysteries/**Will Fastie**

About ten years ago, I went to my first computer trade show. I had to sweet-talk my boss; the company couldn't see a good reason for me to go and, at the time, neither could I. But go I did, and *wow*! What a time! The *mother lode*! I was in hacker heaven (I think I may have been a hacker back then).

Nowadays, when a trade show rolls around, I feel the way I used to when my mother yelled at me for the umpteenth time to take out the trash. Much of the glamour is gone, but I must go for very sound business reasons. This year I went to the National Computer Conference (NCC) and SIGGraph '85, the conference and exposition of the ACM's special interest group on graphics. The NCC was good, and SIGGraph was spectacular.

B. Nessim.

Nothing in the computer industry dazzles quite as much or captures public attention quite as effectively as computer graphics.

NCC

In the past, NCC was my show. Working, as I did, for a company doing systems integration, the need to understand the marketplace for commodity items (computers, disks, controllers, peripherals, etc.) was very great. NCC has always been perceived as a show for DP and MIS; I viewed it as a show for OEMs.

As the microcomputer revolution struck, I noticed that the conference proceeded apace, but the exposition became more DP-oriented. Two years ago I think NCC reached its zenith in that regard—there was very little interest in the OEM side of the market. Last year the show was an incredible bore, but this year, notwithstanding the conclusions of the trade press that the show was off, I thought it was returning to its roots. If I had been in my former life, I would have found much of interest. In this life, there at least were signs of future activity. Here is a quick glimpse.

• **Laser Printers**: There is some action here that may result in lower cost printers by the time fall COMDEX rolls around. Kyocera displayed a print engine that had a separate drum and toner cartridge. Toner is good for about 3000 copies, but the drum can last for about 10,000, lowering the cost of operation considerably. In the Canon engine (Apple, Hewlett-Packard), the drum and toner get replaced at about 3000 copies.

• **Other Printers**: Because NCC does not serve the retail market (that's COMDEX territory), only a few printers were on exhibit. However, I was surprised to see a few new entries in the dot matrix and fully-formed character race, so again look for a busy COMDEX. It's hard for me to believe that companies still enter this crowded market dominated by Epson and Okidata.

• **Hard Disks**: Capacity and performance are up, and price is holding well. I paid the most attention to 5 1/4" drives in the performance class required by the PC AT, for which IBM specifies better than 40 milliseconds for an average access. Priam was the most interesting; after three years of work they have finally solved their linear motor problems and produced a high-performance device (30ms) in the 5 1/4" form/factor. Previously their drive had been too deep.

• **80286-based Machines**: The AT has clearly sparked the market. Whether the machines are AT clones or not, IBM's choice of the next Intel processor establishes it as an important *de facto* standard. Rumors have it that Intel is working on a special version of the 286 for IBM that includes the 80386 memory management technique, and the 386 itself is a natural successor for future systems. *Everybody's* 286 box runs at least 8MHz except, of course, for IBM's. Drat.

• **Tape Systems**: Tape backup is becoming a hot market right now as companies begin to pay attention to basic DP issues long avoided by users of micros. Data integrity and security are well established for mainframes; the word is filtering down. However, there are several competing standards and methodologies that confuse the end user. A new IBM product, the 3480 tape system, introduces a single-spool cartridge using 1/2" tape and with a capacity of 200Mb that is more compact than the traditional Scotch/3M 1/4" cartridges in wide use today. The IBM system is for mainframes, but the existence of the cartridge is the important thing: look for clever third-party vendors to develop low cost systems around that cartridge. This may be the most important development shown at the NCC.

• **Backup**: One software product did catch my eye. It is *FastBack*, a backup program for the PC family from Fifth Generation Systems. It is a significant product because of its very high speed of operation, and it is faster than any other backup program I have encountered. The program performs backup to diskettes, just like the IBM BACKUP command, but it has a very nice visual interface and clever features, such as the ability to alternate between two disk drives automatically. A large number of PCs have been upgraded not only with a hard disk but also with half-height floppies; *FastBack* allows such configurations to be fully exploited.

That's about it. And, of course, that's why so many reporters called the show slow and boring. But I think my list represents significant future developments that we should keep our collective eyes on.

SIGGraph '85

Nothing in the computer industry dazzles quite as much or captures public attention quite as effectively as computer graphics. Witness our slavish devotion to arcade games and to their subsequent in-home version, the Atari 2600. Witness also our disdain for them now, as technology offers more and more and these old(!) things look so primitive, so simple. And note the technical success of "The Last Starfighter," a sci-fi melodrama whose special effects used not a single scale model: everything was done by computer-generated graphics. Something to see, and you should.

SIGGraph is the premier graphics show in the industry. It is hard to describe the excitement I feel as I walk the aisles, observing one miracle after another. From a technical point of view,

D. Mackay, Univ. of Waterloo

M. Wilson

D.Gambino, School of Visual Arts

the graphics capability of even low cost systems is rising dramatically, and this fact was more evident at the show this year than ever before.

I looked for two things. First, I wanted to see how many IBM PCs were on display as the computational engine underlying a graphics system. Second, I wanted to see how far the vendors had come with resolution, color, and speed.

On the first count, I struck gold, but not exactly with PCs. The IBM PC AT was everywhere, doing everything. It was the predominant desktop computer at the show, and it was ubiquitous besides. I could not even begin to recount the firms with product offerings based on IBM equipment; if this is an area of interest, you may be sure that you will soon hear from these companies. It is interesting to note, however, that few firms had products *specifically* for the AT. Most were built with the 8-bit bus of the PC in mind and just demonstrated on the considerably faster AT. I should also note that most of these products should work properly in AT clones like the Compaq 286 which, at 8MHz, are 33% faster than the AT.

I looked for software products designed to take advantage of the IBM Enhanced Graphics Adapter (EGA) and its 640x350, 16-color capability. I saw almost nothing; most of the excitement surrounded products of greater screen resolution and more color choices. Although I think that the EGA is quite good and will become an important, much-copied standard, it represents a middle ground of capability in the graphics market. That means the EGA will be used for business graphics and visual presentations, but lacks the power to be used effectively in demanding, serious graphics applications. IBM has chosen something that can drop in price and be popular, while the graphics market needs devices that stretch the limits of technology.

The EGA is thus a good benchmark against which to measure other products. First, the EGA delivers a resolution of 640x350. Although that resolution is close to popular sizings like 400x400, 512x512, and 600x400, higher resolutions of up to 1024x1024 are becoming feasible and affordable. Some such displays were shown at SIGGraph; expect the vendors to move rapidly here. Second, the EGA delivers a maximum of 16 colors chosen from a fixed palette of 64. Here IBM falters; the open market is demanding and getting 256 from 4096 or even more. A vast array of colors is an important feature, perhaps more important than the resolution. With many hues it is possible to shade objects much more effectively, giving the illusion of smoothness even in coarse resolution. As the resolution rises, of course, such shadings get smoother, but then the color advantage can be applied to ever smaller objects.

SIGGraph was a hotbed of such display adapters. They certainly were superior to the EGA in resolution and color; in performance the comparison is not fair. Because the cost of microprocessors and memory is forever dropping, the manufacturers of graphics adapters are increasingly turning to the solution of a complete graphics subsystem on a plug-in board. The IBM Professional Graphics Controller (PGC) is an example in this genre, including its own 8088 processor and a complete onboard library of graphics display primitives. Within months of IBM's announcement of the PGC, several companies produced clones with much greater performance, due largely to the choice of better processors (80188, 8086, 80186) and faster clock rates. The general market is building devices that are not only faster but include even niftier features. These were in great supply at SIGGraph; expect to see software to drive these boards emerge over the next year.

Another area of interest for me is hard-copy graphics output. I expected more than I saw. In particular, I guess the market must be waiting for HP's LaserJet II (I'm guessing that it will include full-page graphics) before it pounces on laser-generated output. There were very few laser printers in evidence—a surprise. On the other hand, the price of pen plotters continues to drop, so conventional drafting applications should filter downward into smaller and smaller firms with the expected benefit.

Both shows were fun for me, and both had their share of surprises. Next year's NCC is in Las Vegas in June (better than July, but not much) so the heat may mitigate my objectivity. SIGGraph I will follow anywhere. Both are worth the investment for their target audience, and I look forward to reporting on them again. ■

Firms Mentioned in this Column

Kyocero International, Inc.
7 Powder Horn Dr.
P.O. Box 4227
Warren, NJ 07060
(201) 560-0060

Priam Corp.
20 W. Montage Expressway
San Jose, CA 95134
(408) 946-4600

Fifth Generation Systems
7942 Picardy Ave.
Suite B-350
Baton Rouge, LA 70809
(504) 767-0075

Compaq Computer Corp.
20555 FM 149
Houston, TX 77070
(800) 231-0900

Hewlett-Packard
16399 W. Bernardo Dr.
San Diego, CA 92127
(619) 560-9414

IBM Corp.
Entry Systems Div.
P.O. Box 1328
Boca Raton, FL 33432

TANDY GRAM

Alcor C—a serious, comprehensive implementation/**Jake Commander**

In this column a few months back, I took some space to extol the virtues of the C language. Well, I am as adament as ever: I still think C is just about the best language for everyday use by a programmer. It is easy to learn and develop programs in the language and to produce fast, working code in a fraction of the time required to do it in assembly language.

Admittedly, Basic has its uses. It is there in ROM; there is no need to load a compiler or interpreter. And it is possible to become addicted to it because of its simplicity. For example, it is a relatively easy task to open a file, do something with it, and write a new output file containing the manipulated input file.

What takes you five minutes in Basic might take you 20 minutes in C. But so what? The resulting program will probably be machine code running at the raw speed of the microprocessor instead of interpreted speed as with Basic.

For as long as I have been programming in C on my Model 4, I have been using my own 75% completed C compiler. This has some strange side effects in that writing programs for a compiler that is only three-quarters finished means that you become awfully proficient in a subset of the language. Only as each new function becomes integrated into the compiler do you get a chance to exercise that particular feature. For example, my present compiler does not yet support C-type structures (a way to define variables that are accessed as a group). So whenever I program in C on my TRS-80 I have to kludge my way around any problem that involves groups of variables. This isn't really a big deal, because other languages don't support entities like structures, so I tend to use the same techniques I used in a Basic program. (That is one of the reasons I am convinced Basic programmers should find a switch to C relatively easy.) Nevertheless, it is frustrating not to be able to use the entire language on my Model 4.

Alcor C

In that frame of mind, imagine my unrestrained enthusiasm at the prospect of reviewing a complete C compiler. It was my good fortune to receive a review copy of a fully-fledged C compiler with all functions intact—including my

heretofore missing features. This compiler is part of the Alcor C advanced programming system from Alcor Systems, 13534 Preston Rd., Suite 365, Dallas, TX 75240. I remember promising a review of this package a while back, and it is a pleasure to recommend it highly.

I knew it was going to be good as soon as I saw that 1.25" thick manual. At last on my TRS-80 I have a rich set of operators and features guaranteed to keep an avid C programmer happily hacking into the small hours. This package is a serious implementation of the C language and is comprised of many functional parts. This doesn't mean it is difficult to use though; there are a couple of reasons why there are several different modules. First, Alcor's C development system is very versatile. For each way of using the system, there is a different program to support that feature.

Secondly, C itself is a very versatile language. Although comprised of only a few keywords and operators, it is very flexible. As a result, any compiler that hopes to support the entire C language must itself be quite large. Now we bump our heads against the fact that the humble TRS-80 has a mere 48K of RAM (usually) available for programs other than the operating system or Basic. So any code over and above this (if there is going to be room for I/O and edit buffers and such) must be split into parts. The disk operating system itself is split up for just this reason. Hence it makes sense for Alcor to have split their C compiler into logically distinct pieces.

In fact, the compiler consists of five parts: the main compiler and four overlays, each of which deals with a specific part of the C language. This segmentation is normally invisible to the programmer who just sits back and waits for the result when a program is being compiled. However, Alcor's C compiler is busily loading and running whichever module is required at any given point in the compilation process.

Alcor states in their documentation that for the sake of efficiency there are ways to write C code which (to couch it in the vernacular) give the compiler a break. By using common sense in the layout of a program, you can minimize the swapping of compiler overlays. This involves only such disciplines as defining C constants all together in a contiguous section of code. If you don't follow these guidelines, nothing comes out and slaps you on the wrist; it just takes longer to compile your program. The compiler, left to its own devices, does run quite fast. Although by no means the fastest I have ever seen, it is more than adequate for serious work on the TRS-80.

Creating the Source Code

Before inputting anything to the compiler, of course, you must create the source code. This can be done with either a word processor or a text editor, but a text editor is usually preferable. This is the case with the Blaise text editor provided with the Alcor C package, which lets you enter program text and do the usual things like find and replace strings, insert and delete characters, etc. It also provides features that are unlikely to be included in a word processor but are extremely useful to a programmer.

For example, an auto-indent feature is provided. If you want to indent your program text to set it off as a separate loop or whatever, the editor will take your lead as to where to start the next line. If, for example, your program reaches a point where characters start at line position eight, instead of making you tab to that position on each new line, this text editor will tab to position eight whenever you hit RETURN. This continues until you change the start position of the next line or turn the feature off.

The editor also neatly gets around the lack of some of the keyboard characters on the TRS-80 such as left and right square brackets, curly braces, tilde, and other symbols that are important in the C language. (Please Tandy, give us these keys!) Alcor's editor provides these characters by using the CLEAR key as an escape character. For example, to get an underline character, you hit CLEAR and then the 7 key. If you are a Model I user with no way even to display these characters, Alcor allows alternate characters to be used in their place. Unfortunately, this saddles you with an ugly non-standard C notation, which I guess still beats not being able to use C at all. In total, ten extra characters are provided by this method.

The Blaise editor program is a screen-oriented text editor, which means that you can scroll around the screen at will, hopping from one line to another, making alterations at will. You are not confined to editing single lines of text as in old fashioned Microsoft Basic. I must say I found the editor a cinch to use – it is enough of an improvement over my previous editor to convince me to make it my current editor of choice.

I found a couple of the text editor commands a little wordy. For instance, to direct the editor to jump to a certain line for editing, you go into the command mode with a CLEAR-C, then type the command SHOWLINE followed by a line number. I would have thought it would have been much simpler to use a CLEAR-J for JUMP or CLEAR-G for GOTO followed by a line number. I am a lousy typist and need all the help I can get when sending an editor to a specific line—CLEAR-C SHOWLINE 100 is too many characters for such a simple exercise.

One feature I liked which could have been taken a stage further is the ability to undelete a line. This allows you to recover from a mistakenly deleted line and also to undelete a line to a new position. It is a pity that the feature can be used on only a single line at a time.

Compilation

The Alcor C compiler takes the source code that has been produced by the editor (which is assumed to have an extension of /C) and outputs a file to disk with the same name but with an extension of /OBJ for object. As it goes through its compilation process, the screen displays the text that is currently being compiled.

The object file output from the C compiler can be processed in one of four ways. If desired, it can be used immediately after being output as an object file by the compiler. To do this, you use a runtime interpreter called RUNC.

This program takes a /OBJ file and interprets it. This is because in its normal mode of operation, the C compiler outputs what is called p-code. An abbreviation of pseudo-code, p-code is understandable only to a specially written interpreter—in this case the RUNC program. P-code has certain advantages that make it popular in many development languages. It tends to be very compact, allowing for very small programs, and it saves having to link the compiled program with any libraries (such as floating-point arithmetic routines) it may need to use. All these runtime libraries are in fact part of the RUNC interpreter program. So to test your C program, all you have to do is type RUNC followed by your program name.

The editor neatly gets around the lack of some of the keyboard characters on the TRS-80.

Other options allow different modes of execution of the compiled program. Two programs, OPTIMIZE and CODEGEN, in the Alcor C development package can manipulate the compiled program to produce an enhanced version. version.

OPTIMIZE takes a p-code object file and scans the code looking for redundancies and long-winded code. Because a compiler is only an automatic process, it can never output code of the same caliber that a human programmer can. The optimizer cleans up the more obvious pieces of inefficient p-code. Alcor claims that it will reduce the size of a program by between 10 and 30%.

The CODEGEN command takes p-code and converts it to machine code directly executable by the Z80. This makes the code run extremely fast, because the RUNC interpreter is now bypassed completely. However, converting the p-code to machine code involves an enlargement of the program; it may take two or three machine code instructions to represent a single p-code instruction. Therefore the resultant program will be two to three times larger but will execute much, much faster.

All three of the above types of object file can be input to yet another program called LINKLOAD. This utility is the all-important linking loader which allows separately compiled programs and/or libraries to be linked. It is this program that produces a stand-alone machine code version of your C program which can be executed directly from DOS. Libraries allow disk file manipulation, string handling, single and double precision floating-point number crunching, and character input/output. These are all linked with your C program using LINKLOAD. To their great credit, Alcor doesn't even ask for a royalty on any code you sell using their runtime libraries. All they require is documentation of the fact that your code contains Alcor runtime support.

Documentation

The documentation that comes with such an extensive package as this is obviously of extreme importance. Thankfully, Alcor has taken the time and effort to get this right. The manual is about as complete as anyone could wish. Over 400 pages in length, the documentation is as comprehensive to the complete neophyte as to the advanced C user. The manual is divided into volumes covering the editor, the compiler, the runtime interpreter, and the object-code utilities. The library functions are described in full (and there are lots of them).

There is even a huge tutorial covering the C language itself which is useful both as a tutorial and as a refresher on parts of the language used infrequently.

There is a great deal of information in this hefty tome. Happily, it has even been laid out with care. Paragraph headings jump out. Examples are set apart and clearly labeled. Lots of white space keeps the whole thing digestible. Even the editors of *Creative Computing* would have a hard time improving on it. Myself, I can't find fault with it. Maybe I should complain about the color of the cover or something just so as not to sound too sycophantic.

There is one other advantage of this thick manual for Alcor Systems. Anybody wishing to pirate a copy of this package will think more than twice. You see, nobody in his right mind is going to copy 400 double-sided pages of text. Without the text you ain't got the package, and that's just the way it should be. Alcor deserves all the revenue from this superlative work. I recommend it. Highly. If this package had been available four years ago, IBM wouldn't have stood a chance. ■

OUTPOST: ATARI

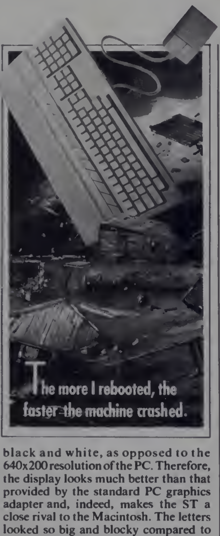
Atari ST: The good, the bad, and the ugly/**Sheldon Leemon**

After months of waiting for my new Atari 520 ST system, its arrival was almost anticlimactic. Although I reacted to the announcement of the machine in January with enthusiasm, during the long waiting period that followed, some of the initial optimism faded as the ever-present doomsayers spun their scenarios for disaster. It was true that Jack Tramiel, Atari's new proprietor, had built Commodore into the premier survivor of the home computer wars, but along the way he had also acquired a reputation for announcing more products than he intended to deliver, for sacrificing quality for price, and for alienating computer retailers and third party software developers alike.

So while on paper the ST looked like a breakthrough new-generation product, there were still plenty of reasons to be cautious. As with any new computer product, the first units would undoubtedly have more problems and less software than more established machines. The price would no doubt be higher at first. So, as the waiting dragged on, it became easier and easier to wait.

Blasé as I was, I could not ignore that big stack of cartons for long. It contained my 520 ST, two single sided 3.5" disk drives, and two monitors—a high-resolution black-and-white screen and an RGB color display. As I hooked up the system and turned it on, my disinterested facade quickly began to crumble. Since the operating system is not yet available in ROM, I had ample opportunity to check the transfer speed of the disk drive as it loaded TOS from disk. The ST loaded the entire 200K+ file in about 25 seconds. When it finished loading, I found the GEM desktop staring me in the face. For those of you unfamiliar with GEM, it is a user interface program which attempts to put a Macintosh face on antiquated computers like the IBM PC. It uses icons, "drop-down" menus, a mouse—the whole nine yards. I have used GEM on the PC, and I found the implementation on the ST to be identical, except for a couple of important differences.

First, the Atari monochrome monitor displays 640x400 pixels in living



The more I rebooted, the faster the machine crashed.

black and white, as opposed to the 640x200 resolution of the PC. Therefore, the display looks much better than that provided by the standard PC graphics adapter and, indeed, makes the ST a close rival to the Macintosh. The letters looked so big and blocky compared to the skinny little characters found on most displays that I had to count them to make sure that there were really 80 columns (there were).

Some of the screen clarity may stem from the large overscan area that leaves a thick border around the display, so that the actual display area is only about 9" (diagonal) on a 12" screen. While the color display has no worse resolution than that provided by the PC color card and much better color, the monochrome mode gives the ST real credibility in performing serious business applications which primarily display text.

The second difference was that on the ST, GEM looked like it was running about twice as fast as it does on the PC. Windows that would crawl open on the IBM burst open on the ST. I could feel the commencement of a slight elevation of the old blood pressure. Speed. Power. Lots of RAM. Fast disk drives. Maybe this ST was the breakthrough it was cracked up to be.

Unfortunately, the feeling of euphoria did not last long, as I realized that I had no way to put the ST through its paces. The only software I had was Logo—a version so slow that I wondered if the interpreter was written in Logo. The fact that I had sprung the $1700 to buy the developer's package hardly made me any better off than the average buyer. Although the package came with development software like a C compiler and assembler, it was essentially useless out of the box, because the text editor needed for writing programs was to be sent out later separately by the manufacturer (apparently much later, since six weeks after getting the machine, I'm still waiting).

Moreover, the celebrated 6" stack of documentation that comes with the development package turned out to contain more hints than answers. The bulk of the material consisted mainly of photocopies of Digital Research documentation that, though somewhat related to the machine, was by no means ST specific. These included a CP/M 68K manual and the full manual for development under GEM on the IBM PC. Only a few pages of the documentation actually came from Atari, including some sketchy material on the BIOS routines, the keyboard, printer codes, and a source code listing for the boot ROMs. Of the 1500 or so pages included, more material was devoted to the Kermit protocol file transfer program (250 pages) than to the ST.

With such modest development tools available, it is small wonder that application programs were not ready for early buyers of the machine. This is a real shame, because seeing the speed at which GEM desktop ran gave me an idea. If GEM ran at PC AT speed on the ST, how would programs such as *GEM Write* and *GEM Draw* stack up on the ST when compared to versions of the same software running on the AT? And if the ST ran applications at AT-speed, then what real difference in potential computing power would there be between the $1500 ST system with a hard disk and the $5000 AT system?

Although it may be that lack of software has caused me to wax philosophical, I can't help feeling that if Atari had arranged to bundle these applications with the machines (or even provided them to dealers), many buyers would be able to make head-to-head comparisons that would cause them to ask some serious philosophical questions (like why is the sky Big Blue?).

Listing 1.

```
TO HEBREW
MAKE "N 220
REPEAT 27 [TYPE CHAR :N
TYPE CHAR 32 MAKE "N :N -1]
END

TO MAN
TYPE CHAR 28
PRINT CHAR 29
TYPE CHAR 30
TYPE CHAR 31
END

TO ATARI
TYPE CHAR 14 TYPE CHAR 15
END
```

In the end, I was reduced to discovering odd facts about the ST. For example, did you know that although the ST character set conforms fairly closely to the extended ASCII used on the IBM PC, it also includes the characters for the Atari Logo, the entire Hebrew alphabet, and a picture of a man smoking a pipe? Some people say that the picture of the man looks like Jack Tramiel himself, smoking a cigar, but I think it looks more like Hugh Hefner. By typing in the Logo programs in Listing 1, you can decide for yourself.

Even this idle exploration was not to last. After a few short hours of poking around, my ST started to act like it had eaten too much cotton candy and was looking for the men's room. I started to get duplicate images of the Busy Bee icon all over the screen. Then, random dots started speckling the screen as if bees really were the cause of yellow rain. I knew the end was near when mushroom clouds began to appear. The more I rebooted, the faster the machine would crash, until finally I turned it on and nothing happened. Sure, I had had fun for a couple of hours, but I really didn't feel as though I had gotten my money's worth.

Fortunately, help was but a phone call away. Dialing into the SIG*Atari section of CompuServe (a hotbed of information about the new ST series), I discovered from a number of messages that I was not alone. A large percentage of the first batch of STs, it seems, had shown the symptoms I have described. In most cases, however, the problem was a minor one, caused by the chips coming loose in shipping. Some people had cured the difficulty by taking the cover off and pushing down on the chips, or by extracting and reinserting them. Others had straightened out the shielding, making sure that it did not short out the circuit board and soldering it into place when they were done. Even proceeding with extreme caution, I was able to complete the "repair" in somewhat less than an hour. Since then, my 520 has operated flawlessly.

Still, the problem that was a mere annoyance to me would have been far more serious if it had happened to someone who was afraid to touch the keyboard, let alone take the computer apart. Somehow, I can't picture going into a store and hearing "Attention K-Mart shoppers. Over in aisle 10, there will be a short demonstration of Atari computer home repair."

While the malfunctions encountered by ST owners do not rank with the terrible quality control problems that plagued Commodore products when that company was under Mr. Tramiel's direction, they still must be dealt with. My suggestion to potential ST owners is that they buy their computers from a reliable dealer with a liberal replacement policy, and go so far as to have the dealer operate it at the store for a trial "burn-in" period to make sure that it works properly.

By the time you read this, the software shortage may be alleviated somewhat and the high ST failure rate may be just an ugly memory. When there are plenty of working STs in the field, running software that demonstrates their speed and power, we may have to run a column entitled "The Atari 520 ST: Good, Better, and Best." ■

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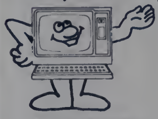

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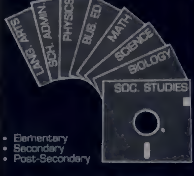

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COMMODORE'S PORT

More on Amiga: Software, Basic, and IBM compatibility/**Sheldon Leemon**

Commodore has the hottest new computer around, but you won't find the word Commodore or its company logo anywhere on the machine. You can't blame them, though, for trying to disassociate their bargain basement image from a premium product like the Amiga. After all, the performance of the machine is much more important than the name. I was in love with this computer when it was still the product of an obscure manufacturer of game cartridges and joysticks; at the time it was known only by the code name Lorraine. And it always makes me a little queasy when I hear somebody ask if it is compatible with his 1541 disk drive or 1525 printer.

To start Amiga off on the right foot, Commodore held an elaborate press conference on July 23 at Lincoln Center in New York, which gave many of those unfamiliar with the machine a first glimpse of its raw power. Even long-time Amiga watchers were somewhat surprised by the announcement that Commodore plans to offer optional software to allow the machine to emulate the IBM PC. The press conference covered most of the basic features of the machine, but some nagging questions remained unanswered. The most concern centered around who was going to sell the machine. Only a couple of dealers were announced by name, and many publications made much of the fact that the big chains like Computerland and Entre were not going to handle the Amiga.

To strengthen his company's sales position, CEO Marshall Smith hit the road immediately after the launch. The mission of this Commodore caravan was to press the flesh with computer retailers in 37 U.S. cities. If the meeting I attended was any indication, it doesn't appear that Commodore will have a problem finding enough dealers to make the machine readily available by Christmas. The only real problem may be getting computers to those dealers in sufficient quantity in time for the holiday season.

For me, one of the most important results of Commodore's Magical Mystery Tour was that a few precious demo machines found their way to my local dealers' showrooms. This meant that after a two-year wait, I was finally able to get some hands-on experience with the machine. The first thing that I did, of course, was to run the graphics demos. Though the images were impressive in their own right, there was a particular trick I wanted to try.

It doesn't appear that Commodore will have a problem finding enough dealers to make the machine readily available by Christmas.

The Intuition Operating System (which may be called something else by the time you read this because of a possible trademark conflict with a PC program called *Intuit*) lets you "pull down" the screen of any application, revealing the Workbench screen behind it. So while some of the fancy animation demos were running, I moved the mouse to where the scroll bar would be and started to drag. Much to my gratification, the demo screen "slid" down, while the animation continued to run with only a slight disruption. This amounts to having the Operating System fine-scrolling the display autonomously, a feat that I consider pretty amazing.

Amiga Software

From the graphics demo programs, I moved on to the early demo copies of the various application programs that Commodore intends to market. The most complete program I had was *TextCraft*, an introductory word processing package. It is very easy to use and has a unique "format template" function that does all of the formatting for many standard types of documents. *GraphiCraft* is a full-featured drawing program, but what impressed me most was not any special feature of the program, but rather the ability to work with 32 colors at the same time.

MusicCraft, the "simple" music program, provides an impressive array of features. It allows you to compose, to custom tailor the waveform and tone of each voice, and to use the computer keyboard like a piano keyboard. Tinkering with the tone was particularly interesting; there are lots and lots of "switches" that let you make minute adjustments of the sound, and you can even specify the waveform by drawing its shape with the mouse. The program comes with a whole array of pre-set instrument sounds that you can load in and modify or use as-is.

Basic

The version of Basic that came with the evaluation machines was not the Microsoft version that Commodore says it will ship with the machine, but is extremely interesting to play with just the same. This version was written by Metacomco, the British firm that wrote the multi-tasking Operating System and DOS for the Amiga, and which reportedly also wrote the interpreter upon which Atari ST Basic is based.

Because much of the graphics muscle of the Amiga comes from the hardware processors used to speed up the display, it stands to reason that manipulation of bit-map graphics would be fast even from Basic. But knowing it and seeing it are two different things. Those of you familiar with the Basic used by the IBM PC or the Commodore 128 know that those interpreters have bit-map graphics commands that allow you to "save" the image of a rectangular screen area to a Basic variable array and redraw the image elsewhere on screen. But as anyone who has used the PUT and GET or GSHAPE and SSHAPE commands knows, the image is not redrawn nearly fast enough for animation, and in the case of a fairly large image, it may take quite a while to draw. On the Amiga, GSHAPE restores the image as fast as could be done by machine language bit manipulation on other machines.

One of the Basic demo programs has you "capture" a rectangle of color by selecting the upper left and lower right corners of the image with the mouse. It then redraws the saved image where the mouse is pointing whenever the mouse button is pressed, in effect turning the image into a drawing pen. The program is only a few lines long and operates quickly enough to allow you to draw smooth lines as quickly as you can drag the mouse. I defined a narrow "pen" and wrote my name in script with no problem. A larger pen composed of a block of 16 colors about the size of a Rubik's cube was reproduced just about as quickly.

The sound capabilities of the machine are also fully supported by Basic. One of the programs on the Basic disk reads in a data file containing sampling information for a tom-tom, and lets you play this extremely realistic-sounding instrument from the keyboard. Using the built-in software speech synthesizer from Basic is a snap. The NARRATE command uses a phonetic text string for input (the word *computer*, for example, is rendered phonetically as "kumpyuw4ter"). Those of you familiar with the *SAM* program for Atari and Commodore computers will recognize that the phonetic system is exactly the same as on those machines. But if you prefer plain English, the TRANSLATE$ function will make the translation automatically, allowing you to command the computer to speak a sentence as easily as to have it print the words to the screen.

One of the most impressive programs on the Basic disk shows how the language provides access to the full range of system resources by allowing you to call Operating System functions directly. This program opens up five different windows and has a different Basic program operating in each. As with any system window, each display can be sized, moved around the screen, and made active by clicking in the window. One of the five programs is a simple Basic text processor that works much more quickly even with four other programs running at the same time than would most such Basic programs running alone.

As I said before, the Basic version I saw was not the one being shipped with the machine. But I was told by a Commodore representative that the Microsoft Basic version that would be supplied with the computer would have comparable features. I hope that it will also have a little better editing facilities than the Metacomco Basic, which does not even support full screen editing.

IBM Emulator

Finally, I had a chance to play with the fabled IBM emulator. First, I attached an external 5.25" drive that looked suspiciously like a 1571 (in fact, I was told it was a 1571 with connectors for the Amiga added). Then, I started the

For true believers like me, the question of PC-compatibility is largely a charade.

machine normally, loading the Operating System and DOS from the internal 3.5" drive. From the DOS command line, I ran the EMU4 program, that is also on a 3.5" disk. The screen turned black with green letters, and a message told me to insert PC-DOS into the external drive and press any key to boot DOS. I did so and was first greeted with a message that told me there was 395K of memory available to the emulator (on a 512K Amiga). Then came the familiar PC-DOS sign-on screen. Interestingly enough, the internal drive (which was now drive B:) could be used to read disks from PC-compatibles that use 3.5" drives (like the HP portable). In fact, it was possible to format 3.5" disks in PC format and to transfer programs from 5.25" to 3.5" disks. Thus, it is quite possible to run the emulator with only 3.5 disks (or even the Amiga hard disk), once you have transferred DOS and your programs. But when you format the smaller disks for PC compatibility, they will hold only 360K instead of their normal 880K, and the machine will be unable to read those disks when it is in Amiga mode.

When I inserted a Lotus *1-2-3* program disk, the program loaded normally. You could also say that it ran, but it might be more appropriate to say that it walked. The operation was said to take

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place at about 60% IBM speed, which looked about right. Also, it was not possible to operate the graphics section of the program, because the emulator, in its current primitive state, will run only programs that are compatible with the IBM monochrome adapter. *WordStar* ran, albeit slowly. This was to be expected, because it is one of the programs advertised to work. So I switched to programs that were not on the list.

When I tried to run my original copy of Microsoft *Word*, a heavily protected word processor, I got a message that said "The weed of crime bears bitter fruit. Now trashing your pirate disk." I assumed this meant the program thought my original was an unauthorized copy and quickly pulled it out of the drive before the wrath of Microsoft was visited upon the innocent.

Next I tried one of my own programs, a Yahtzee dice game that I had written in C. Much to my surprise, even though the program does direct reading and writing to screen memory, it ran. It acted as if it had a bit of brain damage, though, leaving non-fatal garbage on the screen at times, and scoring one hand a minus 27,306 points. A simple text editor written in C wouldn't load and locked up the machine entirely, so I decided that *Sidekick* was probably out of the question.

Armed with this experience, I was able to confront a Commodore representative with some reasonably intelligent questions about the emulator. What about programs that use the graphics adapter? Though the current emulator will not run them, the final version will (it is interesting to note that MacCharlie, a $1700 hardware PC emulator for the Macintosh will run only monochrome programs). As for the slow speed of the emulator, I was told that modifications to the software would improve the speed to about 80% of IBM's, and that a small hardware board called the Accelerator would bring the emulator up to full speed.

Despite careful questioning, I still have no firm technical details on the hardware card. I know only that it is a simple, inexpensive board that plugs into the expansion port on the side and is said to speed up memory access. From that description, it seems safe to rule out a board that contains Intel chips like the 8088 or 8087, as had been rumored. As for copy-protected disks, Commodore-Amiga says only that it will try to deal with each such program on an individual basis.

For true believers like me, however, the question of PC-compatibility is largely a charade. Sure, we recognize that many people would never even hear about the great features of the machine if it didn't have the emulator. After all, plenty of prospective computer buyers first ask "Is it IBM compatible?" and if the answer is negative, they just stop listening. But from an objective standpoint, the Amiga needs a PC-emulator like the AT needs a Vic 20 emulator.

Amid all the hoopla about the great graphics and sound of the Amiga, one simple fact often passes unnoticed. With an 8 MHz processor, special hardware to speed up the display, up to 8.5Mb of RAM, true multi-tasking, and an open bus for the addition of hard drives, the Amiga is a power user's dream come true. Graphics and sound demo programs are flashy and take relatively little time to set up, so such demos make up most of the software we have seen on the Amiga so far.

As a result, many people already think of the Amiga as a toy computer or a game machine. But if there were Amiga versions of Lotus *1-2-3*, *Multimate*, and *dBase III*, IBM users would be forced to consider a machine that could run all three at the same time, and run each faster and better than the PC. The day that I can run that kind of demonstration on the Amiga will no doubt come. And, if that still doesn't impress them, I'll show them how I can play a quick game of *Pac-Man* while my spreadsheet recalculates. ■

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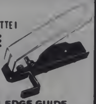

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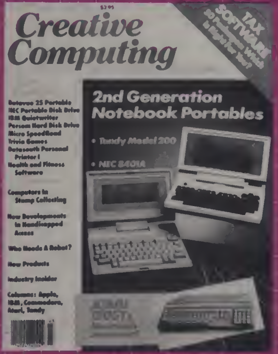

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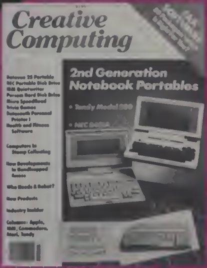

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	1. Own	2. Plan to Buy	
		1-6 months	7-12 months
IBM PC or compatible	A.	L.	W.
Apple II Series (II, IIc, IIe)	B.	M.	X.
Apple Macintosh	C.	N.	Y.
Commodore 64 or 128	D.	P.	Z.
Commodore Amiga	E.	Q.	1.
Atari XL, XE, ST	F.	R.	2.
Tandy/Radio Shack	G.	S.	3.
Any Laptop/portable	H.	T.	4.
Other (specify)	J.	U.	5.
None	K.	V.	6.

Please indicate which of the following peripherals you plan to buy either in the next 6 months or in the next 7-12 months.

	3. Plan to Buy	
	1-6 months	7-12 months
Hard disk drive	7.	14.
Dot matrix printer	8.	15.
Daisy wheel printer	8.	16.
Plotter	10.	17.
Monitor	11.	16.
Modem	12.	16.
Power protection device	13.	20.

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481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500

Void after January 31, 1986

CC11851

4. Where do you use a computer?
21. ☐ Business 22. ☐ Home 23. ☐ School

5. How many computers do you own?
24. ☐ 1 25. ☐ 2-3 ☐ 26. ☐ 3 or more

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